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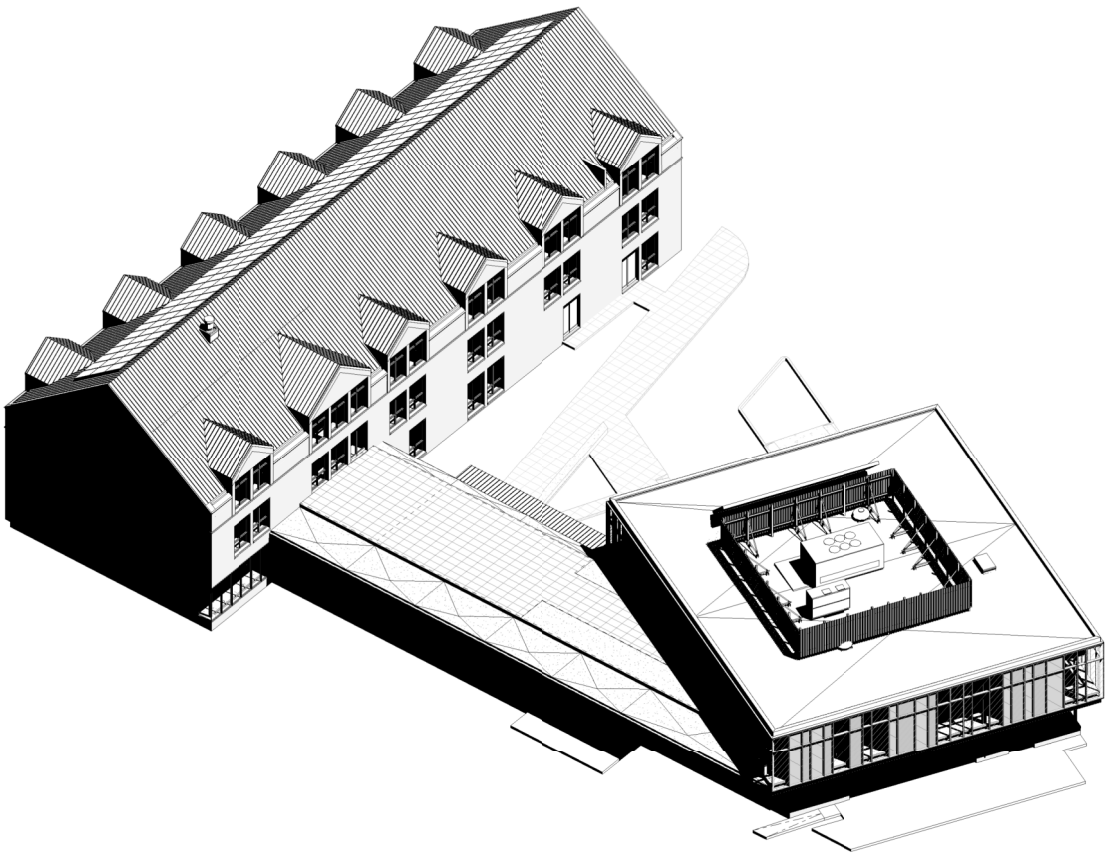

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TABLE OF CONTENTS

DIVISION 14 - CONVEYING EQUIPMENT

SECTION

DIVISION 21 - FIRE SUPPRESSION

SECTION

DIVISION 22 – PLUMBING

SECTION

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

SECTION

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION

APPENDICES

DIVISION 01
GENERAL REQUIREMENTS

SECTION 013113

PROJECT COORDINATION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the project coordination as specified herein, including, but not limited to, the following:

1. General project coordination procedures.

2. Conservation.

3. Coordination drawings.

4. Requests for Information (RFIs).

5. Administrative and supervisory personnel.

6. Cleaning and protection.

1.3 RELATED SECTIONS

A. Project Meetings - Section 013119.

B. Submittal Procedures - Section 013300.

C. Product Requirements - Section 016000.

D. Closeout Procedures - Section 017700.

1.4 COORDINATION

A. Coordinate construction operations included in various sections of these specifications to ensure efficient and orderly installation of each part of the work. Coordinate construction operations included under different sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in the sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to ensure maximum accessibility for required maintenance, service, and repair.

3. Make provisions to accommodate items scheduled for later installation.

4. Provide plumbing, device and electrical layout walkthrough with proposed junction boxes locations.

B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the Owner and separate contractors where coordination of their work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules.

2. Installation and removal of temporary facilities.

3. Delivery and processing of submittals.

4. Progress meetings.

5. Project closeout activities.

D. Conservation: Coordinate construction operations to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the work.

E. Conduct a walk-through for device and electrical layout required with junction boxes installed in proposed locations.

1.5 SUBMITTALS

A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components.

1. Show the relationship of components shown on separate shop drawings.

2. Indicate required installation sequences.

3. Comply with requirements contained in Section 013300, "Submittal Procedures."

B. Staff Names: Within 15 days of commencement of construction operations, submit a list of the contractor's principal staff assignments, including the superintendent and other personnel in attendance at the project site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.

1. Post copies of the list in the project meeting room, the temporary field office, and each temporary telephone.

1.6 REQUESTS FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.

2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.

2. Project number.

3. Date.

4. Name of Contractor.

5. Name of Architect.

6. RFI number, numbered sequentially.

7. RFI subject.

8. Specification Section number and title and related paragraphs, as appropriate.

9. Drawing number and detail references, as appropriate.

10. Field dimensions and conditions, as appropriate.

11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

12. Contractor's signature.

13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or software-generated form with substantially the same content as indicated above and acceptable to Architect.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow five working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Architect's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.

3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use CSI Log Form 13.2B or software-generated form with substantially the same content and acceptable to Architect. Include the following:

1. Project name.

2. Name and address of Contractor.

3. Name and address of Architect.

4. RFI number including RFIs that were returned without action or withdrawn.

5. RFI description.

6. Date the RFI was submitted.

7. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of Conditions: Require the installer of each major component to inspect both the substrate and conditions under which work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Architect.

B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.2 CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at substantial completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Excessively high or low humidity.
5. Solvents.
6. Chemicals.
7. Light.
8. Radiation.
9. Puncture.
10. Abrasion.
11. Heavy traffic.
12. Soiling, staining, and corrosion.
13. Bacteria.
14. Rodent and insect infestation.
15. Combustion.
16. Electrical current.
17. High-speed operation.
18. Improper lubrication.
19. Unusual wear or other misuse.
20. Contact between incompatible materials.
21. Destructive testing.
22. Misalignment.
23. Excessive weathering.
24. Unprotected storage.
25. Improper shipping or handling.

26. Theft.

END OF SECTION

SECTION 013119

PROJECT MEETINGS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. To enable orderly review of progress during construction and to provide for systematic discussions of problems, the Architect will conduct project meetings throughout the construction period.

B. In general, project meetings will be held at the job site in accordance with a mutually acceptable schedule.

C. The purpose of the project meetings is analysis of problems that might arise relative to execution of the work.

1.3 RELATED SECTIONS

A. The Contractor's relations with his subcontractors and materials suppliers, and discussions relative thereto, are the Contractor's responsibility as described in the General Conditions, and are not part of the agenda of project meetings.

1.4 QUALITY ASSURANCE

A. Persons designated by the Contractor to attend and participate in project meetings shall have all required authority to commit the Contractor to solutions as agreed upon in the project meetings.

1.5 SUBMITTALS

A. Agenda Items: To the maximum extent possible, advise the Architect at least twenty-four (24) hours in advance of the project meeting regarding all items to be added to the agenda.

B. Minimum Agenda

1. Review work progress since last meeting.

2. Note field observations, problems and decisions.

3. Identify problems which impede planned progress.

4. Review off-site fabrication problems.

5. Develop corrective measures and procedures to regain schedule.

6. Coordinate projected progress with other prime contractors.

7. Review submittal schedules, expedite as required to maintain schedule.

C. Minutes: The Contractor shall compile minutes of each project meeting and shall distribute copies to the Owner and the Architect. The Contractor shall make and distribute such other copies as he wishes. The

Architect and/or Owner may issue amendments to the minutes as necessary. Contractor shall issue same to other interested parties.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.1 MEETING SCHEDULE

A. Coordinate with the Architect as required to establish a mutually acceptable schedule for project meetings.

3.2 MEETING LOCATION

A. To the maximum extent practicable, project meetings shall be held at the job site. Provide adequate space and facility including table, chairs, and lighting for proper conduct of meeting.

3.3 ATTENDANCE

A. To the maximum extent practicable, assign the same person or persons to represent the Contractor at project meetings throughout the construction period. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspects of the work are involved.

END OF SECTION

SECTION 013200

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes administrative and procedural requirements for documenting the progress of construction during performance of the work, including but not limited to, the following:

1. Preliminary Construction Schedule.
2. Contractor's Construction Schedule.
3. Submittals Schedule.
4. Daily construction reports.
5. Material location reports.
6. Field condition reports.
7. Special reports.
8. Construction photographs.

1.3 RELATED SECTIONS

A. Project Coordination - Section 013113.

B. Progress Meetings - Section 013119.

C. Submittal Procedures - Section 013300.

D. Closeout Procedures - Section 017700.

1.4 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.

1. Float time belongs to Owner.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.

3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

G. Major Area: A story of construction, a separate building, or a similar significant construction element.

H. Milestone: A key or critical point in time for reference or measurement.

I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.5 SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article and in-house scheduling personnel to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:

1. Scheduled date for first submittal.

2. Specification Section number and title.

3. Submittal category (action or informational).

4. Name of subcontractor.

5. Description of the Work covered.

6. Scheduled date for Architect's final release.

C. Preliminary Construction Schedule: Submit two printed copies; one a single sheet of reproducible media, and one a print.

D. Preliminary Network Diagram: Submit two printed copies; one a single sheet of reproducible media, and one a print; large enough to show entire network for entire construction period.

E. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.

1. Submit an electronic copy of schedule, and labeled to comply with requirements for submittals. Include type of schedule Initial or Updated and date on label.

F. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.

2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.

3. Total Float Report: List of all activities sorted in ascending order of total float.

4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.

G. Material Location Reports: Submit two copies at monthly intervals.

H. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

I. Special Reports: Submit two copies at time of unusual event.

1.6 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting.

B. Photographer Qualifications: An individual of established reputation who has been regularly engaged as a photographer for not less than three years.

C. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013119, "Project Meetings." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.

2. Verify availability of qualified personnel needed to develop and update schedule.

3. Discuss constraints, including work stages, area separations, interim milestones, and partial Owner occupancy.

4. Review delivery dates for Owner-furnished products.

5. Review schedule for work of Owner's separate contracts.

6. Review time required for review of submittals and resubmittals.

7. Review requirements for tests and inspections by independent testing and inspecting agencies.

8. Review time required for completion and startup procedures.

9. Review and finalize list of construction activities to be included in schedule.

10. Review submittal requirements and procedures.

11. Review procedures for updating schedule.

1.7 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

PART 2 PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.

2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

B. Time Frame: Extend schedule from date established for commencement of the Work to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.

2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.

4. Startup and Testing Time: Include not less than 10 days for startup and testing.

5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.

2. Work under More Than One Contract: Include a separate activity for each contract.

3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.

4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date. Delivery dates indicated stipulate the earliest possible delivery date.

5. Work Restrictions: Show the effect of the following items on the schedule:

   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use of premises restrictions.
   f. Provisions for future construction.
   g. Seasonal variations.
   h. Environmental control.

6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Startup and placement into final use and operation.

7. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.

d. Completion of electrical installation.
e. Substantial Completion.

E. Milestones: Include milestones indicated in the schedule.

F. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

G. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for commencement of the Work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.

3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

4. Use "one workday" as the unit of time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

a. Preparation and processing of submittals.
b. Purchase of materials.
c. Delivery.
d. Fabrication.
e. Installation.

2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.

3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

   a. Sub-networks on separate sheets are permissible for activities clearly off the critical path.

E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.

2. Description of activity.

3. Principal events of activity.

4. Immediate preceding and succeeding activities.

5. Early and late start dates.

6. Early and late finish dates.

7. Activity duration in workdays.

8. Total float or slack time.

9. Average size of workforce.

F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.

2. Changes in early and late start dates.

3. Changes in early and late finish dates.

4. Changes in activity duration’s in workdays.

5. Changes in the critical path.

6. Changes in total float or slack time.

7. Changes in the Contract Time.

2.5 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.

2. List of separate contractors at Project site.

3. Approximate count of personnel at Project site.

4. High and low temperatures and general weather conditions.
5. Accidents.
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, and losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of authorities having jurisdiction.
12. Change Orders received and implemented.
13. Construction Change Directives received.
14. Services connected and disconnected.
15. Equipment or system tests and startups.
16. Partial Completions and occupancies.
17. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.

2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, duration's, actual starts and finishes, and activity duration's.

3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.

2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

3.2 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Provide progress photographs by the Project Team.

B. Photographic Film: Medium-format, 2-1/4" x 2-3/4".

C. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

D. Preconstruction Photographs: Before starting construction, take four color photographs of Project site and surrounding properties from different vantage points, as directed by Architect. Show existing conditions adjacent to property.

E. Periodic Construction Photographs: Take four color photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.

1. Field Office Prints: Retain one set of prints of periodic photographs in field office at Project site, available at all times for reference. Identify photographs the same as for those submitted to Architect.

F. Final Completion Construction Photographs: Take eight color photographs after date of Substantial Completion for submission as Project Record Documents. Architect may direct photographer for desired vantage points.

END OF SECTION

SECTION 013300

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete submittal requirements as specified herein, including, but not limited to, the following:

1. Shop drawings and samples.

2. Integrated drawings.

1.3 RELATED SECTIONS

A. Constrction Progress Documentation - Section 013200.

PART 2 PRODUCTS

2.1 SHOP DRAWINGS AND SAMPLES

A. General

1. The Contractor shall be responsible for coordinating the schedule for submittal of shop drawings and samples with his progress schedule and the requirements of the Contract Schedule, and submit a coordinated schedule of submission of all shop drawings and samples to the Architect.

2. Failure of the Contractor to schedule and submit shop drawings and samples in ample time for checking, correction, and rechecking will not justify any delay in the Contract Schedule. Allow ample time for items to be tested, including time for retesting if the tests or mock-ups fail.

3. Samples, shop drawings, manufacturers' literature, and other required information shall be submitted in sufficient time to permit proper consideration and action on same before any materials and items are delivered on the work. Stagger submissions so that the Architect can review the documents in an orderly and timely manner. All samples of materials requiring laboratory tests shall be submitted to the laboratory for testing not less than 90 days before such materials are required to be used in the work. All other samples, manufacturers' literature, and other sample information shall be submitted for approval not less than 30 days before such materials are required to be used in the work.

4. Shop drawings for each Section of the work shall be numbered consecutively, and the numbering system shall be retained throughout all revisions. Each drawings shall have a clear space for the stamps of the Contractor, Architect, and one of the Architect's consultants.

5. All shop drawings shall be thoroughly checked by the Contractor for compliance with the Contract Documents before submitting them to the Architect and shall bear the Contractor's stamp of approval certifying that they have been so checked. Any shop drawings submitted without this stamp of

approval and certification, and shop drawings which, in the Architect's opinion, are incomplete, contain errors or have not been checked, or only checked superficially, will be returned unchecked by the Architect for re-submission by the Contractor.

6. In checking shop drawings, the Contractor shall verify all dimensions and field conditions and shall check and coordinate the shop drawings of any Section or trade with the requirements of all other Sections or trades whose work is related thereto, as required for proper and complete installation of the work. The Architect will review shop drawings. The Architect's acceptance of shop drawings is for design only and not method of assembly or erection. Acceptance shall in no way be construed as (1) permitting any departure whatsoever from the Contract Documents; (2) relieving the Contractor of full responsibility for any error in details, dimensions, omissions, or otherwise that may exist; (3) relieving the Contractor of full responsibility for adequate field connections, erection techniques, bracing, or deficiencies in strength; (4) relieving the Contractor of full responsibility for satisfactory performance of all work and coordination with the work of all subcontractors and other contractors; or (5) permitting departure from additional details or instructions previously furnished by the Architect. Acceptance of such drawings shall not be construed as a complete check, nor shall it relieve the Contractor from responsibility for proper fitting of the work, nor from the necessity of furnishing any work which may not be indicated on shop drawings when approved. The Contractor shall be solely responsible for any quantities which may be shown on the shop drawings.

7. No work shall be fabricated, manufactured, or installed from shop drawings stamped "Revise and Resubmit" or "Rejected," and such shop drawings shall be corrected and resubmitted by the Contractor until accepted by the Architect. At least one complete set of "No Exceptions Taken and/or Make Corrections Noted" shop drawings shall be kept at the site in the Contractor's field office for reference at all times. "Revise and Resubmit" or "Rejected" shop drawings shall not be permitted at the site.

8. Submittals Marked "No Exceptions Taken": Submittals which require no corrections by the Architect will be marked "No Exceptions Taken."

9. Submittals Marked "Make Corrections Noted": Submittals which require only a minor amount of correcting shall be marked "Make Corrections Noted." This mark shall mean that checking is complete and all corrections are obvious without ambiguity. Fabrication will be allowed on work marked "Make Corrections Noted" provided such action will expedite construction and noted corrections are adhered to. If fabrication is not made strictly in accordance with corrections noted, the item shall be rejected in the field, and the Contractor will be required to replace such work in accordance with corrected submittals.

10. Submittals Marked "Revise and Resubmit" or "Rejected": When submittals are contrary to contract requirements or too many corrections are required, they shall be marked "Revise and Resubmit" or "Rejected." No work shall be fabricated under this mark. The Architect shall list his reasons for rejection on the submittals or in the transmittal letter accompanying their return. The submittals must be corrected and resubmitted for approval.

11. NOTE: Submittals reviewed and marked approved, with or without added notes, (i.e. "No Exceptions Taken" or "Make Corrections Noted") do not relieve the Contractor from meeting the requirements of the contract documents.

12. All shop drawings and samples shall be identified as follows:

    a. Date of submittal.
    b. Title of project.
    c. Name of Contractor and date of his approval.
    d. Name of subcontractor or supplier and date of submittal to Contractor.
    e. Number of submission.

f. Any qualification, departure, or deviation from the requirements of the Contract.
g. Federal Specification or ASTM number where required.
h. Such additional information as may be required by the Specifications for the particular material being furnished.

13. If the Contractor wishes to deviate from the materials or details as shown in Specifications or Drawings, he shall submit the proposed deviation with shop drawings and/or samples stating the extent and the materials or details being replaced. The Contractor shall also submit information on the allowed credit or extra cost required for the proposed deviation, and also all information relating to the work of other Sections revised by the proposed deviation.

14. The Architect will review and approve shop drawings and samples for approval within 15 calendar days, but only for conformance with the design concept of the work and with information contained in the Contract Documents.

15. Incomplete shop drawings will be returned without checking for proper submission, and this shall not be considered as cause for delay of the work or extra compensation to the Contractor.

16. The Contractor shall submit appropriate transmittal forms with every submittal of shop drawings, manufacturer's literature, and samples. All reproducibles shall be rolled on cardboard tubes for resubmittal. The Contractor shall submit all required shop drawings, manufacturer's literature and samples in accordance with the procedures specified herein.

17. Unless otherwise specifically directed by the Architect, make all shop drawings accurately to a scale sufficiently large to show all pertinent features of the item and its method of connection to the work.

18. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

19. The Contractor shall submit one copy of each standard referred to in the Specifications (ASTM, Fed. Spec., etc.) with the submission of each respective shop drawing, sample, or literature.

B. Submission of Shop Drawings

1. Architectural Work: Submit pdf of each shop drawing to the Architect for approval. If approved, the Architect will return pdf stamped "No Exceptions Taken" or "Make Corrections Noted," and the Contractor shall print the required number of copies. In the event the Architect returns pdf stamped "Revise and Resubmit" or "Rejected," the Contractor shall make indicated changes and resubmit pdf to the Architect.

2. Structural Work and Mechanical Work: Submit pdf of each shop drawing to the Engineer, with pdf to the Architect. If accepted, the Architect shall return pdf stamped "No Exceptions Taken" or "Make Corrections Noted," and the Contractor shall print the required number of copies. In the event the Architect returns pdf stamped "Revise and Resubmit" or "Rejected," the Contractor shall make indicated changes and resubmit pdf to the Engineer and the Architect.

3. Prints: The Contractor shall provide all prints or shop drawings as reasonably required by subcontractors, material suppliers, superintendents, inspectors, and others as required for the work, or as directed by the Architect. The Contractor shall pay all costs in connection with printing and distribution of shop drawings.

C. Submission of Manufacturer's Literature, Including Catalog, Catalog Cuts, Brochures, Charts, Test Data, and Similar Information

1. Manufacturer's literature will receive consideration only when accompanied by the transmittal form properly filled out, as indicated, and listing each item of literature, as well as the Specification Section and paragraph numbers describing such materials. Any deviations from contract requirements shall be stated on the above form or attached to it.

2. Architectural Work: Submit pdf of manufacturer's literature to the Architect for acceptance. If accepted, the Architect will return pdf stamped "No Exceptions Taken" or "Make Corrections Noted." The Contractor shall resubmit pdf of correct or corrected literature of all submissions stamped by the Architect "Revise and Resubmit" or "Rejected."

3. Structural Work and Mechanical Work: Submit pdf of manufacturer's literature to the Engineer and the Architect. If accepted, the Architect will return pdf stamped "No Exceptions Taken" or "Make Corrections Noted." The Contractor shall resubmit pdf of correct or corrected literature to the Engineer for all submissions stamped "Revise and Resubmit" or "Rejected" by the Engineer.

4. All copies of manufacturer's literature required to be resubmitted hereunder shall be original printed material. Reproductions of printed material will not receive consideration.

D. Submission of Samples

1. All samples shall be submitted in triplicate unless otherwise indicated in the Specifications.

2. Samples will receive consideration only when accompanied by the transmittal form properly filled out, as indicated, and listing each sample, as well as the listing of any ASTM, Federal or other standard references specified or applicable and such additional information as may be required by the Specifications for the materials being submitted. Any deviation from the contract requirements shall be so stated on the above form or attached to it.

3. The Architect shall have the right to require submission of samples of any materials, whether or not specifically indicated in the various Sections of the Specifications.

4. Unless otherwise specified, samples of sufficient size to indicate general visual effect shall be submitted. Where samples must show a range of color, texture, finish, graining, or other similar property, the Contractor shall submit sets of pairs illustrating the full scope of the range.

5. One (1) sample of each submission will be returned to the Contractor. Samples stamped "Revise and Resubmit" or "Rejected" by the Architect shall be resubmitted in triplicate by the Contractor.

6. All samples stamped "No Exceptions Taken" or "Make Corrections Noted" shall be kept at the site in the Contractor's field office facilities for reference at all times. "Revise and Resubmit" or "Rejected" samples shall not be kept at the site.

2.2 INTEGRATED DRAWINGS

A. The HVAC subcontractor shall prepare a Drawing or Drawings showing duct work, heating and sprinkler piping. This Drawing shall include location of grilles, registers, etc., and access doors in hung ceilings. Locations shall be fixed by elevations and dimensions from column center lines and/or walls.

B. The HVAC subcontractor shall prepare and distribute to the Plumbing and Electrical subcontractors, the General Contractor, and to the Architect a reproducible of the above.

C. The HVAC subcontractor shall lay out on his reproducible the reflected ceiling plan, beam soffit elevations, ceiling heights, roof openings, etc.

D. The Plumbing subcontractor shall lay out on his reproducible the piping, valves, clean-outs, etc., indicating locations and elevations and shall indicate the necessary access doors.

E. The Electrical subcontractor shall indicate on his reproducible the fixtures, large conduit runs, clearances, pull boxes, junction boxes, sound system speakers, etc.

F. The General Contractor shall indicate on his reproducible any structural framing, ceiling hangers, etc.

G. The General Contractor shall call as many meetings with the subcontractors as are necessary to resolve any conflicts that become apparent. He will call on the services of the Consultant Engineer or Architect where necessary. The General Contractor is responsible for the coordination of the Drawing or Drawings.

H. On resolution of the conflicts, each subcontractor shall enter his own work on the HVAC subcontractor's reproducible, which shall become the master or integrated Drawings. The master reproducible shall be signed by each contributing subcontractor to indicate his acceptance of the arrangement of the work.

I. A reproducible copy of the master integrated Drawing will be prepared by the HVAC subcontractor. The General Contractor will make distribution.

J. Each subcontractor shall prepare his Shop Drawings in accordance with the integrated Drawings. No work will be permitted without approved Shop Drawings. It is therefore essential that this procedure be instituted as quickly as possible.

PART 3 EXECUTION

3.1 COORDINATION OF SUBMITTALS

A. Prior to submittal for Architect's review, use all means necessary to fully coordinate all material, including the following procedures:

1. Determine and verify all field dimensions and conditions, materials, catalog numbers and similar data.

2. Coordinate as required with all trades and with public agencies involved.

3. Secure all necessary approvals from public agencies and others and signify by stamp, or other means, that they have been secured.

4. Clearly indicate all deviations from the Contract Documents.

B. Unless otherwise specifically permitted by the Architect, make all submittals in groups containing all associated items; the Architect may reject partial submittals as not complying with the provisions of the Contract Documents.

END OF SECTION

SECTION 014000

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

1.3 RELATED SECTIONS

A. Project Coordination - Section 013113.

B. Testing and Inspection - Section 014523.

C. Divisions 3 through 32 Sections for specific test and inspection requirements.

1.4 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Mockups establish the standard by which the Work will be judged.

D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.5 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.6 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1. Curtain Wall Systems/Exterior Storefront Systems
2. Exterior Soffit/Masonry
3. Exposed Interior Concrete Floor
4. Stair 3 Tread/Riser and Guardrail
5. Terrace Guardrail
6. MW-06 Bar Booth
7. MW-10/11 Moveable Wood Panel
8. MW-12 Wood Wall Panel
9. MW-13 Ceiling Supported Shelves
10. Institute Bench

C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

D. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of New York and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system,

assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.

1. Contractor responsibilities include the following:

a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
d. When testing is complete, remove assemblies; do not reuse materials on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.

2. Notify Architect seven days in advance of dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

6. Demolish and remove mockups, unless otherwise directed by the Architect.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 014339

MOCK-UPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work of this Section includes all labor materials, equipment and services necessary to complete the mock-ups as shown on the drawings and/or specified herein.

1.2 QUALITY ASSURANCE

A. Coordination: Coordinate preparation of mock-ups with performance of construction activities. Construct for approval sufficiently in advance of performance of related construction activities to avoid delay.

1. Prior to execution of each mock-up, carefully review, correct, coordinate and submit all aspects of each item included in, or required for, the mock-ups for review by the Architect. Verify that each item conforms in all respects with the specified requirements.

2. Coordinate execution of each mock-up with fabrication, purchasing, testing, delivery, other submittals, and with related activities that require sequential activity.

3. Coordinate transmittal of different types of submittals for related elements of the mock-up work so review of mock-up will not be delayed by the need to request submittals for coordination and concurrent review.

4. The Architect reserves the right to withhold action on any review or submittals for related elements of the mock-up because of required coordination with other submittals.

B. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals and to review mock-ups, including construction and reconstruction(s) of mock-ups.

PART 2 PRODUCTS

2.1 MOCK-UPS

A. Before beginning the work of applicable sections, execute mock-ups, to demonstrate items made under submittals and to show aesthetic effects, qualities of materials, installation and workmanship to be expected in the completed work.

B. Execute the mock-ups to comply with the following requirements, using materials and methods indicated for the final work:

1. Unless otherwise indicated, executed mock-ups at the Project site in locations to be selected by the Architect.

2. Sizes and location as directed by the Architect, using materials as required.

3. Include work of all trades required in the finish work.

4. Demonstrate the proposed range of aesthetic effects and workmanship.

5. Allow sufficient time for proper curing, and drying.

6. Rework, remove, or recreate mock-up for the purpose of the Owner's and the Architect's approval as a control sample of the terms and methods of construction of scope of work described below in Item 2.3 as may be required and as directed by the Architect.

7. Obtain the Architect's acceptance of each mock-up before proceeding with the work of the Contract.

8. Clearly label and protect mock-ups in a manner to ensure that they are undamaged at time of final completion of the work.

9. Remove and dispose of mock-ups, unless the Architect allows the mock-up to become part of the final work.

2.2 PROCESSING BY ARCHITECT

A. Architect's Distribution: The Architect will advise, in writing, of the appropriate action regarding the mock-up after review.

B. Accepted mock-ups will be the standard by which related work will be judged.

2.3 MOCK-UPS AND SAMPLES

A. Exterior Mockups: Mock-up shall include:

1. 4 curtain wall glazing panels.

2. Bent aluminum fascia at curtain wall parapet/head/sill.

3. Wood soffit.

4. Masonry wall.

5. 2 storefront panels on ground floor.

B. Provide mockups and samples as required and indicated by other specification sections.

END OF SECTION

SECTION 014523

TESTING AND INSPECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the testing and inspection requirements as specified herein.

1.3 RELATED SECTIONS

A. Requirements for testing and inspection shall be described in various Sections of these Specifications. Where no testing and inspection requirements are described herein but the Owner decides that testing should be performed, the Owner may proceed with additional testing and inspection to be performed at his own expense.

B. Work Not Included

1. Unless otherwise noted in this Section or other Section of work, the Owner will select a pre-qualified independent testing laboratory and inspection professional.

2. Unless otherwise noted in this Section or other Sections of work, the Owner will pay for all initial services of the testing laboratory and inspection professionals as further described in Article 2.1 of this Section of these Specifications.

3. All third-party testing shall be by Vassar College.

1.4 QUALITY ASSURANCE

A. The testing laboratory will be qualified to the Owner's approval in accordance with ASTM E 329-18 "Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection."

B. Testing, when required, will be in accordance with all pertinent codes and regulations and with selected standards of the American Society for Testing and Materials.

1.5 PRODUCT HANDLING

A. Promptly process and distribute all required copies of test reports and related instructions to ensure all necessary retesting and/or replacement of materials with the least possible delay in progress of the work.

PART 2 PRODUCTS

2.1 PAYMENTS FOR TESTING AND INSPECTION SERVICES

A. Initial Services: The Owner will pay for all initial testing and inspection services.

B. Retesting: When initial tests and inspections indicate non-compliance with local Codes and the Contract Documents, all subsequent retesting occasioned by the non-compliance shall be performed by the same testing laboratory and inspectors and the costs thereof will be deducted by the Owner from the Contract Sum.

2.2 CODE COMPLIANCE TESTING AND INSPECTION

A. Inspections and tests required by Codes or Ordinances, or by a plan approval authority, shall be paid by for by the Owner unless otherwise noted in this Section or other Sections of work. Retesting or inspection as required shall conform to the requirements of Article 2.1 B of this Section.

2.3 CONTRACTOR'S TESTING

A. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

B. Where operating tests are specified, the Contractor shall test his work as it progresses, on his own account, and shall make satisfactory preliminary tests in all cases before applying for official tests.

C. Tests shall be made in the manner specified, for the different branches of the work. Each test shall be made on the entire system for which such test is required, wherever practical. In case it is necessary to test portions of the work independently, the Contractor shall do so without extra compensation. The Contractor shall furnish all labor, material and apparatus, make corrections and conduct the official test. The test will be conducted in the presence of a representative of the Architect.

D. All parts of the mechanical and electrical work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition. All defects disclosed by these tests shall be corrected to the satisfaction of the Architect and Engineer without any additional cost to the Owner. Tests shall be repeated on this repaired or replaced work if deemed necessary by the Architect. The Architect shall be notified at least forty-eight (48) hours in advance of all tests, and shall be represented at tests that he deems necessary. The Contractor shall furnish all necessary instruments, other equipment, and personnel required for such tests.

E. Required certificates of inspection, testing or approval shall be secured by the Contractor and promptly delivered by him to the Architect.

F. If the Architect or Engineer is to observe the inspections, tests or approvals required by the Contract Documents, he will endeavor to do so promptly and, where practicable, at the source of supply.

PART 3 EXECUTION

3.1 COOPERATION WITH TESTING LABORATORY AND INSPECTORS

A. Representatives of the testing laboratory and inspectors shall have access to the work at all times. Provide facilities for such access in order that they may properly perform their functions.

3.2 SCHEDULES

A. Establishing Schedule: By advance discussions with the inspection service and testing laboratory selected by the Owner, determine the time required to perform inspections and tests and to issue each of its findings. Provide all required time within the construction schedule.

B. Revising Schedule: When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the inspectors and testing laboratory as required.

C. Adherence to Schedule: When the testing laboratory is ready to test according to the determined schedule but is prevented from testing or taking specimens due to incompleteness of the work, all extra costs for testing attributable to the delay will be back-charged to the Contractor.

3.3 TAKING SPECIMENS

A. All specimens and samples for testing, unless otherwise provided in these Contract Documents, will be taken by the testing laboratory; all sampling equipment and personnel will be provided by the testing laboratory; and all deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory.

END OF SECTION

SECTION 015000

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the temporary facilities and controls as shown on the drawings and specified herein, including but not limited to, the following:

1. Field office.
2. Construction sign.
3. Stairs, and ladders.
4. Rodent control.
5. Temporary elevator.
6. Construction fence.
7. Fire protection.
8. Temporary utilities.
9. Temporary toilets.
10. Temporary site access.
11. Water and snow control.
12. Environmental controls.

1.3 RELATED SECTIONS

A. Product Requirements - Section 016000.

B. Execution Requirements - Section 017300 for cleaning.

PART 2 PRODUCTS

2.1 GENERAL

A. Arrange for and provide temporary facilities and controls as specified herein and as required for the proper and expeditious prosecution of the work. Pay all costs, except as otherwise specified, until final acceptance of the work unless the Owner makes arrangements for the use of completed portions of the work after substantial completion.

B. Make all temporary connections to utilities and services in locations acceptable to the local authorities having jurisdiction thereof; furnish all necessary labor and materials, and make all installations in a manner subject to the acceptance of such authorities; maintain such connections; remove the temporary installation and connections when no longer required; restore the services and sources of supply to proper operating condition.

C. A Staging Plan shall be submitted by the Contractor for approval by the Owner. The Staging Plan shall locate all temporary facilities and services, including parking for the Contractor's employees, within the limits of the staging areas, and shall allot ground space to Subcontractors for storage of materials, and the erection of sheds and tool houses. Materials and equipment can only be stored in the staging area. No parking for Contractor's or Subcontractors' employees' vehicles will be allowed in undesignated parking areas. The staging area shall be maintained in good repair, free of mud and standing water, and passable at all times. All materials stored within the project site are the responsibility of the Contractor. At the completion of the work, the staging areas shall be restored to their original condition, gravel removed, topsoil replaced and graded and re-seeded.

2.2 TEMPORARY FIELD OFFICES

A. Provide and maintain a field office with a telephone and internet at the job site with not less than 200 square feet of space. The office shall be complete with light, heat, air conditioning, toilet facilities, electric water cooler, plan racks, four-drawer metal file with lock, shelves for samples, tables, chairs, and janitor service. When it becomes possible to establish an office in the building, office accommodation of approximately the same size as those in the field offices, including the services above, shall be provided and maintained until the issuance of a certificate of substantial completion. Temporary offices shall be removed when no longer required. Provide a telephone and internet line.

2.3 CONSTRUCTION SIGN

A. No signs or advertisements will be allowed to be displayed on the premises without the approval of the Architect.

B. One construction sign on the site shall be provided by the Contractor and shall be subject to the review of the Architect and the approval of the Owner.

C. Erect the construction sign on the site where directed by the Architect. Provide sign approximately 4 ft. x 8 ft. in size, of 3/4 in. plywood with structural supports. Use Douglas Fir Overlaid Plywood, Grade B-B high density, exterior, good two sides, complying with PS-1. The sign shall be primed and given two coats of alkyd white paint. Lettering shall be black of a type, size, and lay-out as directed by the Owner. Sign shall contain the name of the Building, Owner, Architect, Contractor, and such other reasonable information as the Architect or Owner may require.

2.4 RODENT CONTROL

A. Institute an effective program of rodent control for the entire site within the construction limits. Cooperate with local authorities and provide the regular services of an experienced exterminator who shall visit the site at least once a month for the entire construction period. Provide marked metal containers for all edible rubbish and enforce their use by all employees. Containers shall be emptied and the contents removed from the site as often as required to maintain an adequate rodent control program. If the program of rodent control used is not effective, take whatever steps are necessary to rid the project of rodents, and such action shall not be the basis of a claim for additional compensation or damages.

2.5 TEMPORARY CONSTRUCTION OPENINGS

A. Provide openings in slabs, walls, and partitions where required for moving in large pieces of equipment of all types. Close and/or restore all openings and finish them after the equipment is in place. Structural modification, if required, shall be subject to review by the Architect.

2.6 TEMPORARY ELEVATOR

A. Provide a temporary elevator for necessary service during construction operations after the hoistway enclosures are completed and electrical power is available; use temporary machines, or at the Contractor's option, use permanent machines, if they are available in due time for the required services.

B. The temporary elevator shall include temporary wood cars with suitable gates, including temporary hoistway doors, all designed in accordance with the local and state safety requirements.

C. The temporary services shall include qualified operating and maintenance personnel to perform the work in connection with the temporary operations.

D. Upon completion of temporary use, all work or damaged permanent parts are to be replaced and all equipment placed in first-class condition equal to new.

E. Subcontractors shall not assume use of a temporary elevator; coordinate with General Contractor/CM.

2.7 TEMPORARY FENCE

A. Provide and maintain an 8-foot high temporary fence to enclose the area at the job site and to guard and close effectively the designated area. Provide gates at locations where required for access to the enclosed area. Gates shall be cross-braced, hung on heavy strap hinges, and shall have hasps and padlocks.

B. Remove the fence upon completion of the work or at such time before final completion as directed by the Owner.

2.8 FIRE PROTECTION

A. Provide and maintain adequate fire protection, ready for instant use, distributed around the project.

B. Make arrangements for periodical inspection by local fire protection authorities and insurance underwriters inspections. Cooperate with said authorities and promptly carry out their recommendations.

C. Open fire will not be permitted within the building enclosure or on the project site.

2.9 TEMPORARY HEAT AND VENTILATION

A. Provide temporary heat as required during construction to protect the work from freezing or frost damage. In areas of the building where work is being conducted, the temperature shall be maintained as specified in the various sections of the Specifications, but not less than 45 degrees Fahrenheit. Under no circumstances shall the temperature be allowed to reach a level that will cause damage to any portion of the work which may be subject to damage by low temperatures.

B. Until the building, or any major portion thereof, is enclosed, temporary heating shall be by smokeless portable unit heaters of type listed by Underwriter's Laboratories, Factory Mutual, and the Fire Marshall. Pay for fuel, maintenance, and attendants required in connection with the portable unit heaters. Interior or exterior surfaces damaged by the use of these space heaters shall be replaced by new materials or be refinished.

C. The building shall be considered enclosed when it has reached the stage when exterior walls have been erected, the roof substantially completed, exterior openings closed up either by the permanently glazed windows and doors, or by adequate temporary closing, and the building is ready for interior masonry and plastering operations.

D. After the building, or any major portion thereof, has been enclosed, the permanent heating system as specified below may be used for temporary heat.

E. When the permanent heating system, or a suitable portion thereof, is in operating condition, the system may be used for temporary heating, provided that the Contractor assumes full responsibility for the entire heating system, and pays all costs for fuel, operation, maintenance, and restoration of the system.

F. Provide adequate ventilation as required to keep the temperature of the building within 10 degrees Fahrenheit of the ambient outdoor temperature when such ambient temperature exceeds 70 degrees Fahrenheit, and to prevent accumulation of excess moisture or to prevent excess thermal movement in the building.

G. When the permanent air circulation system, or a suitable portion thereof, is in operating condition, it may be used without refrigeration or chilling, provided that the Contractor assumes full responsibility for the system which he is using, and pays costs for power, operation, maintenance, and restoration of the system. Provide temporary filters to adequately filter air being distributed through the duct work to the supply outlets; disposable filters shall be placed in front of all exhaust registers to keep construction dirt out of exhaust duct work. The Contractor shall thoroughly clean the interior of the air handling units and duct work prior to acceptance of the work.

H. Upon conclusion of the temporary heating period, remove all temporary piping, temporary heating units, or other equipment and pay all costs in connection with repairing any damage caused by the installation or removal of temporary heating equipment. Thoroughly clean and recondition those parts of permanent heating and air circulation systems used for temporary service.

2.10 TEMPORARY LIGHT AND POWER

A. Make all arrangements with the local electric company for temporary electrical service to the construction site; provide all equipment necessary for temporary power and lighting; and pay all charges for this equipment, the installation thereof, and for current used. The electrical service shall be of 120v and 240v for single phase loads up to 30 amps for all construction tools and equipment without overloading the temporary facilities and shall be made available for power, lighting, and construction operations of all trades.

B. In addition to the electrical service, provide power distribution as required throughout structure. The terminations of power distribution shall be at convenient locations in the building. Terminations shall be provided for each voltage supply complete with circuit breakers, disconnect switches, and other electrical devices as required to protect the power supply system.

1. Provide double duplex outlets at not more than 200' o.c. both directions throughout this building.

C. A temporary lighting system shall be furnished, installed, and maintained as required to satisfy minimum requirements of safety and security. The temporary lighting system shall afford general illumination in all building areas and shall supply not less than 150 watt lamps on 30' centers both directions of floor area for illumination in the areas of the building where work is being performed.

D. All temporary equipment and wiring for power and lighting shall be in accordance with the applicable provisions of the governing codes. All temporary wiring shall be maintained in a safe manner and used so as not to constitute a hazard to persons or property.

E. When the permanent electrical power and lighting systems are in operating condition, they may be used for temporary power and lighting for construction purposes, provided that the Contractor assumes full responsibility for the entire power and lighting system, and pays costs for power, operations, maintenance, and restoration of the system.

2.11 TEMPORARY ACCESS TO SITE

A. Construct and maintain in good usable condition all required temporary access to site, and, when no longer required, remove all temporary construction and restore the site.

B. Where streets now in use are within or adjacent to the work, keep the passageways of such streets open to vehicular and pedestrian traffic to building fronting thereon. Maintain constant access for police, fire and ambulance service.

C. Mud carried off the site and into public roads shall be removed immediately by the Contractor.

D. Access to the site for delivery of construction material or equipment shall be made only from locations designated by the Architect.

2.12 TEMPORARY STAIRS, LADDERS, RAMPS, RUNWAYS

A. Provide and maintain all equipment such as temporary stairs, ladders, ramps, runways, and chutes as required for the proper execution of the work.

B. All such apparatus, equipment, and construction shall meet all requirements of the Labor Law and other state or local laws applicable thereto.

C. As soon as permanent stairs are erected, provide temporary protective treads, handrails, and shaft protection.

2.13 TEMPORARY TOILETS

A. Provide and maintain in a sanitary condition enclosed weathertight toilets for the use of all construction personnel at a location within the contract limits. Upon completion of the work, toilets shall be removed. Installation shall be in accordance with all applicable codes and regulations of authorities having jurisdiction. The number of toilet rooms required shall be in accordance with the ANSI Standard Safety Code for Building Construction or other local authorities.

2.14 TEMPORARY WATER SERVICE

A. Provide at a point within 10 feet of the building (or buildings) all water necessary for construction purposes. Make all temporary connections to existing mains; provide temporary meter; and make arrangements to pay for the temporary water service including cost of installation, maintenance thereof, and water used.

B. When the permanent water supply and distribution system has been installed, it may be used as a source of water for construction purposes, provided that the Contractor assumes full responsibility for the entire water distribution system, and pays costs for operation, maintenance, and restoration of the system including the cost of water used.

C. At the completion of the construction work or at such time after the Contractor makes use of the permanent water installation, all temporary water service equipment and piping shall be removed, and all worn or damaged parts of the permanent system shall be replaced and equipment placed in first class condition equal to new.

2.15 WATER AND SNOW CONTROL

A. From the commencement of the construction to the completion of the work, keep all parts of the site and the project free from accumulation of water, and supply, maintain, and operate all necessary pumping and bailing equipment.

B. Remove snow and ice as necessary for the protection and prosecution of the work, and protect the work against weather damage.

C. The Contractor shall take over responsibility for site drainage upon entering the premises and shall maintain such drainage until completion of the work so as not to adversely affect the adjacent areas.

2.16 ENVIRONMENTAL CONTROLS

A. The Contractor shall comply with all applicable Federal, State and local laws, regulations, ordinances, codes and standards concerning environment control. Particular attention shall be given, without limitations, to:

1. Minimization of dust, containment of chemical vapors, control of engine exhaust gases, and control of smoke from temporary heaters.

2. Reduction of water pollution by control of sanitary facilities, proper storage of fuels and other potential contaminants, and prevention of siltation from land erosion.

3. Minimization of noise levels.

4. Proper and legal disposal, off site unless otherwise provided, of waste and spoil resulting from construction activities.

PART 3 EXECUTION

3.1 REMOVAL

A. Maintain all temporary facilities and controls as long as needed for the safe and proper completion of the work. Remove all such temporary facilities and controls as rapidly as progress of the work will permit or as directed by the Architect.

END OF SECTION

SECTION 01 56 39

TEMPORARY TREE PROTECTION

PART 1 — GENERAL

1.0 SUMMARY

A. Section Includes:
1. Tree Protection Fencing.
2. Dust Removal from Foliage of Existing Trees to Remain.
3. Pruning of Existing Trees to Remain.
4. Excavation Within Root Zones of Existing Trees to Remain.

B. Related Sections:
Section 02300, EARTHWORKS.

1.1 REFERENCES

A. ASTM — American Society for Testing Materials: D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

B. ISA — International Society of Arboriculture, Guide for Plant Appraisal, 9th Edition, 2000.

C. WCISA — Western Chapter International Society of Arboriculture, Species Classification, and Group Assignments, 2004.

1.2 DEFINITIONS

A. Acceptance, Accepted, or Acceptable: Acceptance by the Landscape Architect and Arborist in writing.

B. Injury: Any bruising, scarring, tearing, or breaking of roots, branches, or trunk.

C. Undue Stress: Stressed condition of a tree's health caused by the Contractor's failure to meet the requirements of this Section.

D. Drip Line: Line straight down from outermost limits of plant canopy branching.

E. Tree-Protection Zone: The ground area under the canopy of each existing tree to remain plus a continuous 10-foot wide zone outside of and adjacent to the perimeter edge of each tree canopy, unless indicated otherwise on the Drawings, or unless determined otherwise by the Arborist in the field.

F. Arborist: Certified, licensed arborist employed or hired by the Owner to supervise and perform work as described in this Section.

G. Excessive Compaction: Planting area soil compaction greater than 75 percent of maximum dry density as determined by ASTM D 1557.

1.3 ACTION SUBMITTALS

A. General Submittal Requirements: Refer to Section 01300.

B. Product Data:

1. Fungicide to Sanitize Blades of Pruning Tools.
2. Protection Plates.

C. Protection Fence Shop Drawings: Construction details and plan locations of protection fence.

1.4 INFORMATIONAL SUBMITTALS

A. General Submittal Requirements: Refer to Section 01300.

B. Excavation Schedule:
1. Submit schedule indicating trench and tunnel excavations including location and time of planned excavation.
2. Submit revised schedule to the Owner's Representative, Arborist, and the Landscape Architect immediately via fax or e-mail, or daily or as often as required to keep the Owner's Representative, Arborist, and the Landscape Architect up-to-date with any schedule changes.

C. Irrigation Schedule: Submit schedule indicating times and duration of supplemental watering for trees which require supplemental irrigation because the existing irrigation system for the trees is interrupted by construction operations.

1.5 QUALITY ASSURANCE

A. Pre-installation Meeting: Prior to rough grading, demolition and other work, organize and schedule a field meeting with the Owner's Representative, the Arborist and the Landscape Architect to review the requirements of this Section, which existing trees are to remain, tree branches to be removed by the Arborist, protection-fence locations, and to document the condition of each existing trees to remain, tree-protection zones, existing irrigation systems to remain, and trees which require supplemental irrigation if the respective irrigation systems are interrupted by construction operations.

1.6 SITE CONDITIONS

A. Existing Conditions:
1. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing public underground utilities and structures with respective utility companies.
2. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing private underground utilities and structures with the Owner's Representative.
3. Prior to Work commencement and after reviewing the Owner's record irrigation documents, review with the Owner's Representative and clearly mark in field locations of heads, valve boxes and other underground equipment, materials and structures to remain.

1.7 SEQUENCING

A. Protection Fence: Install protection fence prior to beginning other work, including set-up of construction field office, installation of temporary field office utilities, and delivery of materials.

1.8 DAMAGES

A. Existing Trees to Remain Which Will Most Likely Survive Injury or Undue Stress: If it is determined by the Arborist that injury or undue stress has occurred to a tree or its root zone that could affect a tree's health, the Contractor shall pay for costs of labor, materials, fees required by the Arborist to treat the tree in an attempt to bring tree back to the state of health and vigor the tree was in prior to injury or undue stress. If, after two years from date of Final Completion, it is determined by the Arborist that this treatment has not been successful in bringing the tree back to the state of health and vigor it was in prior to injury or undue stress, remove and replace tree with a tree matching in size and variety using an installer designated by the Owner. If an acceptable replacement tree is not available, or if for any reason a replacement tree is not desired by

the Owner, pay damages to the Owner for the value of the tree as assessed by the tree value formula in the ISA Guide for Plant Appraisal, using WCISA Species Classification Group Assignments.

B. Existing Trees to Remain Which Will Most Likely Not Survive Injury or Undue Stress: If a tree that is indicated to remain on the Drawings is removed or destroyed without written approval from the Owner's Representative, a tree is injured, or a tree is caused to be in a condition of irreversible undue stress as determined by the Arborist, remove and replace tree with a tree matching in size and variety using an installer designated by the Owner. If an acceptable replacement tree is not available, or if for any reason a replacement tree is not desired by the Owner, pay damages to the Owner for the value of the tree as assessed by the tree value formula in the ISA Guide for Plant Appraisal, using WCISA Species Classification Group Assignments.

C. Exceptions: Contractor will not be held responsible for failures due to neglect or abuse by Others, vandalism, and other causes outside the Contractor's control, during the Warranty period only if such conditions are reported in writing immediately to the Owner's Representative.

PART 2 — PRODUCTS

2.0 MATERIALS

A. Protection Fence Fabric: Orange snow fence secured with wire tires – 4'-6" height

B. Protection Fence Posts: Standard scaffold poles – 6'-6" height

C. Protection Fence Rails: Standard scaffold poles – secure with standard clamps

D. Water: Potable.

E. Wood Chip Mulch: Same as Section 329300 TREES, PLANTS AND GROUND COVERS.

F. Rope: One-inch diameter, nylon.

G. Fungicide to Sanitize Blades of Pruning Tools: Lysol spray fungicide or accepted substitute.

H. Protection Plates: One-inch thick steel trench plates or 1-1/8-inch thick plywood sheets. Use steel if plywood breaks under equipment loads.

PART 3 — EXECUTION

3.0 EXAMINATION

A. General: Examine site and verify that conditions are suitable to receive Work, and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.

B. Underground Utilities and Structures: Verify that the locations of utilities, structures and other underground items have been clearly marked.

C. Notification of Unsuitable Conditions: Before proceeding with Work, notify the Owner's Representative in writing of unsuitable conditions and conflicts.

3.1 PROTECTION

A. Excessive Soil Compaction within Tree Protection Zone:
   1. Take precautions required to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
   2. Prior to beginning work, spread wood-chip mulch over the tree-protection zone areas where trench excavation or other Work is to occur.
   3. Spread a continuous 4 to 6-inch deep layer of wood chip mulch over areas where Work is to be performed that does not require equipment or vehicles to operate such pruning, hand-digging, air-spading, and water-jetting.
   4. Spread a minimum 12-inch deep continuous wood chip mulch layer overlaid with protection plates over areas where equipment such as trenchers, track excavators, and backhoes must operate.
   5. Do not install wood-chip mulch layer over tree-protection zone areas where trench excavation or other Work is not to occur.
   6. Maintain mulch layer and protection plates in tree-protection zones, including areas adjacent to open trenches, during work operations until Work within tree protection zone is complete.

B. Protection Fencing at Perimeter of Tree Protection Zone:
   1. Install fencing at the perimeter of tree protection zones unless approved otherwise by the Arborist.
   2. Install posts at maximum 6 feet on-center by driving posts at least 3 feet into firm soil as indicated on the Drawings
   3. Attach snow fence to posts with wire ties located at 12 inches on-center, and where necessary using standard scaffold clamps
   4. Temporarily remove snow fence as needed to perform Work within tree protection zones.
   5. Reinstall snow fencing upon completion of Work.

C. Trunk Protection within Tree Protection Zone:
   1. Protect tree trunks with boards in tree protection zones where equipment is to operate.
   2. Using rope, secure 2X4 boards to trunk by spiraling rope around the trunk.
   3. Position 2X4 boards vertically all around trunk with 1 to 2-inch space between boards.
   4. Use boards long enough to extend from top of root flare to bottom of lowest scaffold branch.
   5. Tautly spiral rope continuously around trunks and boards with 1 to 2-inch space between rope spirals.
   6. Secure ends of rope to boards with 2 wire staples per end, so that rope stays taut.

D. Scaffold Branching Protection within Tree Protection Zone:
   1. Protect overhanging tree branches with boards in tree protection zones where equipment is to operate.
   2. Protect branches overhanging work areas with 2X4 or 2X2 boards anchored to branches with spiraled rope in the same manner as indicated for trunk protection.
   3. Arborist will determine extent of protection required in the field.

E. Root Crown Protection within Tree Protection Zone:
   1. Protect root crowns with hay bales in tree protection zones where equipment is to operate.
   2. Ring base of trunk with hay or straw bales.
   3. Install bales side to side with one end of each bale abutting tree trunk.
   4. Prevent displacement of bales by wrapping perimeter ends of bales with continuous strip of 24-inch wide nylon mesh or jute mesh.
   5. Stretch mesh taut and tie ends together securely.

F. Restrictions: Do not allow the following within the tree-protection zones without written approval from the Arborist:
   1. Parking of vehicles or equipment.
   2. Storage of soil, materials, signs, tools, refuse.
   3. Use of trees as support posts, power poles, sign posts or other functions.
   4. Dumping of toxic materials such as paint, petroleum products, non-potable water, and other deleterious materials.

5. Excessive water or heat from construction equipment or burning of trash under or near trees.
6. Excessive water, exhausts or drying resulting from dewatering or other operations.
7. Branch pruning.
8. Injury to tree branches or trunk caused by maneuvering vehicles and equipment.

3.2 TREE BRANCH PRUNING

A. Branches to Be Removed: Branches accepted and designated by the Arborist to be removed.

B. Removal: Schedule the Arborist to remove branches prior to commencement of Work and as needed during construction.

3.3 EXCAVATION WITHIN TREE PROTECTION ZONES

A. Trenching and Tunneling for Utility Lines:
1. Excavate tunnels and trenches with the Arborist present observing the excavation.
2. Excavate utility trenches and tunnels where underground utilities are indicated on the Drawings, unless alternate locations are accepted.
3. Within tree driplines, install utility lines by tunneling under upper 3 feet of soil and roots.
4. Outside of tree driplines within tree protection zones, carefully excavate soil in upper 3 feet of trenches by hand-digging or by using an air-spade or water-jet with soil vacuum in a manner that prevents roots larger than 1-inch diameter from being damaged.
5. Do not cut through major sinker roots, tap roots or roots over a 1-inch diameter unless accepted by the Arborist.
6. When roots larger than 1-inch diameter are encountered and must be moved to facilitate construction, relocate roots in trench backfill, as directed by the Arborist.
7. When roots 1 inch or larger in diameter are encountered so close to new construction that relocation is not practical, Arborist will determine the course of action for roots.

B. Treatment and Protection of Roots Exposed During Excavation:
1. Cut exposed root ends cleanly as directed by the Arborist in the field using sharp, sanitized loppers or saws.
2. Sanitize blades of pruning tools before cutting roots of each tree.
3. Do not chop through roots with hatchets, axes, or shovels.
4. Do not allow exposed roots or exposed pruned root ends to dry out before permanent backfill is placed.
5. Within 10 minutes of exposing roots, continuously keep roots damp by spraying with water or provide temporary soil cover over exposed roots and exposed pruned root ends, or pack roots in wet peat moss or four layers of wet, untreated burlap.
6. Do not allow roots to remain exposed without water spray or damp cover more than 10 minutes after excavation.
7. Wet temporary cover uniformly as often as required to keep roots damp.
8. Support and protect temporary soil cover, peat moss or burlap cover from damage until exposed roots are permanently backfilled.

3.4 SUPPLEMENTAL IRRIGATION

A. Trees to Irrigate: Provide supplemental irrigation to trees that have had their existing irrigation system interrupted by construction operations.

B. Application Method: As directed by the Arborist.

C. Watering Source: Existing Phase 1 irrigation system quick-coupler valves, or other accepted method.

D. Watering Schedule: As determined by the Arborist based on weather and soil conditions.

3.5 DUST CONTROL AND DUST REMOVAL FROM PLANT FOLIAGE

A. Dust Control: Maintain dust control to keep dust occurrence at a bare minimum.

B. Dust Removal: Remove dust from the foliage surfaces of existing plants to remain within the Project area and adjacent to the Project area via spraying with water daily or other less frequent interval if accepted by the Arborist.

3.6 TREE REMOVAL

A. Tree to Be Removed: Remove trees injured by construction operations or trees in a condition of undue stress that are determined by the Arborist to be incapable of restoration to the state of health and vigor existing before construction commenced.

B. Removal Depth: Remove tree roots to a minimum 2 feet below existing grade.

3.7 FIELD QUALITY CONTROL

A. Work Review by Arborist: Coordinate and schedule the Arborist to review temporary removal of chain link protection fences to facilitate work within tree-protection zones, dust removal from foliage, and excavation Work within tree-protection zones.

3.8 CLEAN UP

A. Removal of Protection Materials: Remove snow fence, posts, wood chip mulch, protection plates, boards, rope, and other protection materials after other clean-up work is completed and after heavy machinery, tractors, trucks, and other vehicles and equipment have permanently been removed from the site.

B. Trash and Debris: Remove and dispose of all trash and debris prior to Final Completion.

END OF SECTION

SECTION 016000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete product requirements as specified herein, including, but not limited to, the following:

1. Product delivery, storage and handling.
2. Storage and protection.
3. Identifying markings.
4. Substitution requirements.
5. Temporary use of equipment.
6. General standards.

1.3 RELATED SECTIONS

A. Execution Requirements - Section 017300.

1.4 TRANSPORTATION AND HANDLING

A. Materials, products, and equipment shall be properly containerized, packaged, boxed, and protected to prevent damage during transportation and handling.

B. More detailed requirements for transportation and handling are specified under the technical Sections.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage

1. Store products to allow for inspection and measurement of quantity or counting of units.

2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

4. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

6. Protect stored products from damage and liquids from freezing.

7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 IDENTIFYING MARKINGS

A. Name plates and other identifying markings shall not be affixed on exposed surfaces of manufactured items installed in finished spaces.

1.7 PRODUCT APPROVAL STANDARDS

A. Where the words "or approved equal" or other synonymous terms are used, it is expressly understood that they shall mean that the approval of any such submission is vested in the Architect, whose decision shall be final and binding upon all concerned. All submissions are subject to such approval and shall conform to the requirements of Article 1.8 herein.

1.8 SUBSTITUTIONS

A. After the contract has been executed, the Architect will consider a formal request for the substitution of products in place of those specified, under the following conditions:

1. The request is accompanied by complete data on the proposed substitution substantiating compliance with the Contract Documents including product identification and description, performance and test date, references and samples where applicable, and an itemized comparison of the proposed substitution with the products specified or named by Addenda, with data relating to Contract time schedule, design and artistic effect where applicable, and its relationship to separate contracts.

2. The request is accompanied by accurate cost data on the proposed substitution in comparison with the product specified, whether or not modification of the Contract Sum is to be a consideration.

B. Requests for substitution based on Para (1) above, when forwarded by the Contractor to the Architect for review are understood to mean that the Contractor:

1. represents that he has personally investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified:

2. will provide the same guarantee for the substitution that he would for that specified;

3. certifies that the cost data presented is complete and includes all related costs under this Contract, but excludes costs under separate contracts and the Architect's redesign costs, and that he waives all claims for additional costs related to the substitution which subsequently become apparent; and

4. will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects, at no additional cost to the Owner and at no extension of the contract completion date.

C. Substitutions will not be considered if:

1. they are indicated or implied on shop drawings submissions without the formal request required in Para (1) above; or

2. for their implementation they require a substantial revision of the Contract Documents in order to accommodate their use.

3. The Architect will examine, with reasonable promptness, such substitution submittals, and return of submittals to the Contractor shall not relieve the Contractor from responsibility for deviations and alternatives from the contract plans and specifications, nor shall it relieve him from responsibility for errors in the submittals. A failure by the Contractor to identify in his letter of transmittal material deviations from the plans and specifications shall void the submittals and any action taken thereon by the Architect. When specifically requested by the Architect, the Contractor shall resubmit such shop drawings, descriptive data and samples as may be required to evaluate substitutions.

D. If any mechanical, electrical, structural, or other changes are required for the proper installation and fit of alternative materials, articles, or equipment, or because of deviations from the contract plans and specifications, such changes shall not be made without the consent of the Architect and shall be made without additional cost to the Owner.

1.9 TEMPORARY USE OF EQUIPMENT

A. No equipment intended for permanent installation shall be operated for temporary purposes without the written permission of the Architect.

B. The temporary or trial usage by the Owner of any mechanical device, machinery, apparatus, equipment or any work or materials supplied under this Contract before final completion and written acceptance by the Architect, shall not be construed as evidence of the acceptance of same by the Owner. The Owner shall have the privilege of such temporary and trial usage, for

such reasonable length of time as and when the Architect shall deem to be proper for making a complete and thorough test of same and no claim for damage shall be made by the Contractor for the injury to or breaking of parts of such work which may be caused by weakness or inaccuracy of structural parts or by defective material or workmanship. If the Contractor so elects, he may at his own expense, place a competent person or persons to make such trial usage; such trial usage shall be under the supervision of the Contractor.

1.10 GENERAL REQUIREMENTS

A. In the event that it is necessary for the Contractor to store any materials offsite, he shall first obtain the approval of the Architect. The Contractor shall be responsible for insurance and warehousing charges of any materials stored offsite. The Contractor shall also be responsible for the cost of delivery to the job site of any materials that have been stored offsite.

B. Materials delivered to the job site shall be carefully stored and protected from damage. Damaged material shall not be used in the work. The Contractor shall provide, where directed temporary storage facilities as may be required for the storage of all materials which might be damaged by weather.

C. Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the representative manufacturers, unless otherwise specified.

D. Equipment, plant, and appliances, such as hoists, centering, concrete lifts, construction elevators, cranes, rigging, towers, derricks, walks, ramps, chutes, scaffolding, implements, transportation, cartage and other things necessary and required for the adequate execution of the work and as required by law shall be provided and shall be maintained in good and safe mechanical working order, be responsible for their safe use, and remove them when no longer required. Applicable requirements of OSHA shall become and form a part of this document.

E. During handling and installation of work at project site clean and protect work in progress and adjoining work on a basis of perpetual maintenance. Apply suitable protective covering on newly installed work where reasonably required to ensure freedom from damage or deterioration at time of substantial completion; otherwise, clean and perform maintenance on newly installed work as frequently as necessary through remainder of construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

F. To extent possible through reasonable control and protection methods, supervise performance of work in a manner and by means which will ensure that none of the work whether completed or in progress, will be subjected to harmful, dangerous, damaging, or otherwise deleterious exposures during construction period. Such exposures include (where applicable, but not by way of limitation) static loading, dynamic loading, internal pressures, external pressures, high or low temperatures, thermal shock, high or low humidity, air contamination or pollution, water, ice, solvents, chemicals, light, radiation, puncture, abrasion, heavy traffic, soiling, bacteria, insect infestation, combustion, electrical current, high speed operation, improper lubrication, unusual wear, misuse, incompatible interface, destructive testing, misalignment, excessive weathering, unprotected storage, improper shipping/handling, theft and vandalism.

G. Require installer of each major unit of work to inspect substrate to receive the work, and conditions under which the work will be performed, and to report (in writing to Contractor)

unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

H. Where installations include manufactured products, comply with manufacturer's applicable instructions and recommendations for installation to whatever extent these are more explicit or more stringent than applicable requirements indicated in the Contract Documents.

I. Inspect each item of materials or equipment immediately prior to installation and reject damaged and defective items.

J. Provide attachment and connection devices and methods for securing work properly as it is installed; true to line and level, and within recognized industry tolerance if not otherwise indicated. Allow for expansions and building movements. Provide uniform joint widths in exposed work, organized for best possible visual effect. Refer questionable visual-effect choices to Architect for final decision.

K. Recheck measurements and dimensions of the work as an integral step of starting each installation.

L. Install work during conditions of temperature, humidity, exposure, forecasted weather, and status of project completion which will ensure best possible results for each unit of work in coordination with entire work. Isolate each unit of work from non-compatible work, as required to prevent deterioration.

M. Coordinate enclosure (closing-in) of work with required inspections and tests, so as to avoid necessity of uncovering work for that purpose.

N. Mounting Heights: Except as otherwise indicated, mount individual units of work at industry-recognized standard mounting heights, for applications indicated. In CMU walls mount units at height closest to manufacturer's recommendation so as to minimize cutting of block coursings. Refer questionable mounting height choices to Architect for final decision.

END OF SECTION

SECTION 016350

MODEL ROOM

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 MOCK UP ROOM

A. Typical rooms (and part of a corridor) shall be constructed by the Contractor.

B. The purpose will be to show all materials and fabricated items, windows, lighting equipment and finishes that will be used in the unit.

C. Mock-up shall be built out of sequence of the project and shall set the standard for which all working going forward shall comply with once reviewed by Architect and Owner

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION

SECTION 017300

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:

1. General installation of products.

2. Progress cleaning.

3. Starting and adjusting.

4. Protection of installed construction.

5. Correction of the Work.

1.3 RELATED SECTIONS

A. Cutting and Patching - Section 017329.

B. Closeout Procedures - Section 017700.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.1 EXAMINATION

A. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

a. Description of the Work.
b. List of detrimental conditions, including substrates.
c. List of unacceptable installation tolerances.
d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

G. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg. F.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.

2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

C. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

D. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

E. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

F. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

G. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

H. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

I. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.5 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.7 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

SECTION 017329

CUTTING AND PATCHING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. This Section includes procedural requirements for cutting and patching.

1.3 RELATED SECTIONS

A. Refer to Divisions 3 through 26 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 22, 23 and 26 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.4 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.5 SUBMITTALS

A. Cutting and Patching: Submit a method describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.

3. Products: List products to be used and firms or entities that will perform the Work.

4. Dates: Indicate when cutting and patching will be performed.

5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.

6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.

7. Architect's Approval: Obtain approval of cutting and patching before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.6 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

1. Provide a list of additional elements that are structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal.

B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.

2. Air or smoke barriers.

3. Fire-protection systems.

4. Control systems.

5. Communication systems.

6. Conveying systems.

7. Electrical wiring systems.

C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

1. Water, moisture, or vapor barriers.

2. Membranes and flashings.

3. Exterior wall construction.

4. Equipment supports.

5. Piping, ductwork, vessels, and equipment.

6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.7 WARRANTY

A. Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void warranties.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. In-Place Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. In-Place Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.

5. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

   a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Projects shall generate the least amount of construction and demolition waste possible, by utilizing the following methods:
B. Plan for waste minimization and diversion before project start-up.
C. Minimize waste due to error, poor planning, breakage, mishandling, contamination, or other factors.
D. Reuse or salvage as much material as possible.
E. Recycle all materials that can be feasibly recycled
F. Develop and implement a construction and demolition waste management plan:

1. Establish waste diversion goals for the project by identifying at least five materials (both structural and nonstructural) targeted for diversion. Approximate a percentage of the overall project waste that these materials represent.
2. Specify whether materials will be separated or commingled and describe the diversion strategies planned for the project. Describe where the materials will be taken and how the recycling facility will process the material.
3. Provide a final report detailing all major waste streams generated, including disposal and diversion rates.
4. Alternative daily cover (ADC) does not qualify as material diverted from disposal. Include materials destined for ADC in the calculations as waste.
5. Land-clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion.

G. Waste Diversion Goal

1. This project is committed to achieving a 75% diversion rate, and Four Material Streams. This requires diversion of at least 75% of the total construction and demolition material. Diverted materials must include at least four material streams. One of these streams may be a qualifying commingled waste process/facility.
2. Excavated soil and land-clearing debris do not contribute to this credit.

1.2 WASTE MANAGEMENT PLAN

A. A Waste Management Plan shall contain the following information:

1. Estimates of the types and amounts of waste expected to be generated on the project, where the wastes will be taken for processing, and the expected diversion rates for each type of material.
2. Description of waste streams
3. Planning for waste management should include determining if demolition and construction waste materials will be source-separated on the project site and/or commingled for later separation at the processing site, and how waste materials will be separated (where applicable) and stored on the project site.

1.3 SUBMITTALS

A. All projects:

1. Within 2 weeks of the completion of demolition or deconstruction work and also within 2 weeks of completion of construction or renovation work, submit Waste Tracking forms and Waste Diversion Report(s).

1.4 DEFINITIONS

A. Construction and Demolition Waste: Solid wastes typically including but not limited to, building materials, packaging, trash, debris, and rubble resulting from construction, re-modelling, repair and demolition operations.
B. Commingled Waste: Unlike source separated waste, commingled waste entails collecting multiple types of waste together in a single container for later separation at a waste processing facility.
C. Disposal: Removal of a waste material that will not be reused, returned, recycled, or salvaged from the project site (see Trash).

D. Diversion rate: The amount of waste reused, returned, salvaged, and recycled; divided by the total amount of waste generated, in percent; 100% diversion rate means no waste is disposed.
E. Hazardous: Exhibiting the characteristics of hazardous substances including, but not limited to, ignitability, corrosiveness, toxicity or reactivity.
F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and re-manufactured into a new product for use by others.
G. Recycle: To remove a waste material from the Project site to another site for re-manufacture into a new product for use by others.
H. Return: To give back reusable items or unused products to vendors for credit.
I. Reuse: To utilize a construction waste material in some manner on the Project site.
J. Salvage: To remove a waste material from the Project site to another site for resale or use by others.
K. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
L. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
M. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
N. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, reusable, and trash materials.
O. Waste Stream/Material Stream: a flow of materials coming from a job site into markets for building materials. A stream can be either:

.1 a specific material category that is diverted in a specific way; or
.2 a mixture of several material categories that are diverted in a specific way.

PART 2 - EXECUTION

2.1 PREPARATION

A. Handle waste materials in accordance with appropriate regulations and codes.

2.2 WASTE MANAGEMENT PLAN IMPLEMENTATION AND TRACKING

A. Designate an on-site party (or parties) responsible for instructing workers and overseeing and documenting results of the Waste Management Plan for the Project.
B. Distribute copies of the Waste Management Plan to the Job Site Foreman, each Subcontractor, the Owner, and the Consultant.
C. Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.
D. Lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.
E. Manage waste materials

1. Separate, protect, store and catalogue items to be reused and salvaged.
2. Separate, store, and dispose of hazardous wastes according to local regulations.
3. Transport and deliver non-salvageable items to licensed reuse, recycling or disposal facility.

F. Track the types, amounts, destination, and diversion rates for all waste materials throughout the project, including both demolition and construction phases.

1. For each shipment of waste material from the site or materials reused on the site, track the types, amount shipped, destination (facility name and location), and amount diverted (reused, salvaged or recycled).

a. Request and retain all weight tickets and receipts from all waste destinations such as transfer stations, recycling facilities, etc., showing material weights both disposed and diverted. Retain these for a period of at least two years.

b. Use the Waste Tracking template provided to assist in collecting waste diversion

c. Based on the Waste Tracking information, complete and submit the Waste Diversion Report as described in the Submittals section.

G. Maintain at job site, one copy of following documents:

1. Waste Management Plan, where required under Submittals.
2. Waste Tracking forms.

2.3 STORAGE, PROTECTION AND DISPOSAL

A. Protect surface drainage, storm sewers, sanitary sewers, and utility services from damage and blockage.
B. Waste must be delivered to licensed waste and recycling facilities as per applicable local regulations.
C. Burying of rubbish and waste materials is prohibited unless approved by the authority having jurisdiction.
D. Disposal of volatile materials, mineral spirits, oil, paint thinner and hazardous waste materials into waterways, storm, or sanitary sewers is prohibited.

2.4 CLEANING

A. Remove tools and waste materials on completion of work and leave work area in clean and orderly condition.

B. Clean-up work area as work progresses.

END OF SECTION

SECTION 017700

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Inspection procedures.
2. Project Record Documents.
3. Warranties.
4. Instruction of Owner's personnel.
5. Final cleaning.

1.3 RELATED SECTIONS

A. Execution Requirements - Section 017300.

1.4 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs and photographic negatives, damage or settlement surveys, property surveys, and similar final record information.

6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.

7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

8. Complete startup testing of systems.

9. Submit test/adjust/balance records.

10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

11. Advise Owner of changeover in heat and other utilities.

12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

13. Complete final cleaning requirements, including touchup painting.

14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for Final Completion.

1.5 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment.

2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

4. Submit pest-control final inspection report and warranty.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videotapes.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

a. Project name.
b. Date.
c. Name of Architect.
d. Name of Contractor.
e. Page number.

1.7 PROJECT RECORD DOCUMENTS

A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.

a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
b. Accurately record information in an understandable drawing technique.
c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.

2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.

3. Mark important additional information that was either shown schematically or omitted from original Drawings.

4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.

5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.

C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Note related Change Orders, Record Drawings and Product Data, where applicable.

D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

3. Note related Change Orders, Record Drawings and Record Specifications, where applicable.

E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.8 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" x 11" paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Provide instructors experienced in operation and maintenance procedures.

2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.

3. Schedule training with Owner with at least seven days' advance notice.

4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:

1. System design and operational philosophy.

2. Review of documentation.

3. Operations.

4. Adjustments.

5. Troubleshooting.

6. Maintenance.

7. Repair.

3.2 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
1). Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Replace parts subject to unusual operating conditions.
o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

q. Clean ducts, blowers, and coils if units were operated without filters during construction.
r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
s. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION

SECTION 017823

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the operation and maintenance data as specified herein.

1.3 RELATED SECTIONS

A. Submittal Procedures - Section 013300.

B. Closeout Procedures - Section 017300.

1.4 GENERAL

A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under the Contract.

1. Subcontractors shall prepare operation and maintenance data as specified in this Section and as referenced in other pertinent sections of Specifications.

1.5 FORM OF SUBMITTALS

A. Prepare data in the form of an instructional manual for use by Owner's personnel.

B. Format

1. Size: 8-1/2" x 11".

2. Paper: 20 pound minimum, white for typed pages.

3. Text: Manufacturer's printed data, or neatly typewritten.

4. Drawings

   a. Provide reinforced punched binder tab, bind in with text.
   b. Fold larger drawings to the size of the text pages.

5. Provide fly-leaf for each separate product, or each piece of operating equipment.

   a. Provide typed description of product, and major component parts of equipment.
   b. Provide indexed tabs.

6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:

a. Title of Project.
b. Identity of separate structure as applicable.
c. Identity of general subject matter covered in the manual.

C. Binders

1. Commercial quality three-ring binders with durable and cleanable plastic covers.

2. Maximum Ring Size: 1 inch.

3. When multiple binders are used, correlate the data into related consistent groupings.

1.6 MANUAL FOR MATERIALS AND FINISHES

A. Submit two copies of complete manual in final form.

B. Content, for architectural products, applied materials and finishes

1. Manufacturer's data, giving full information on products.

a. Catalog number, size, composition.
b. Color and texture designations.
c. Information required for re-ordering special-manufactured products.

2. Instructions for care and maintenance.

a. Manufacturer's recommendation for types of cleaning agents and methods.
b. Cautions against cleaning agents and methods which are detrimental to the product.
c. Recommended schedule for cleaning and maintenance.

C. Content, for moisture-protection and weather-exposed products

1. Manufacturer's data, giving full information on products.

a. Applicable standards.
b. Chemical composition.
c. Details of installation.

2. Instructions for inspection, maintenance, and repair.

1.7 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit three copies of complete manual in final form.

B. Content, for each unit of equipment and system, as appropriate.

1. Description of unit and component parts.

a. Function, normal operating characteristics, and limiting conditions.
b. Performance curves, engineering data and tests.
c. Complete nomenclature and commercial number of all replaceable parts.

2. Operation Procedures

a. Start-up, break-in, routine and normal operating instructions.
b. Regulation, control, stopping, shut-down and emergency instructions.
c. Summer and winter operating instructions.

d. Special operating instructions.

3. Maintenance Procedures

a. Routine operations.
b. Guide to "trouble-shooting".
c. Disassembly, repair and reassembly.
d. Alignment, adjusting and checking.

4. Servicing and Lubrication Schedule

a. List of lubricants required.

5. Manufacturer's printed operation and maintenance instructions.

6. Description of sequence of operation by control manufacturer.

7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.

a. Predicted life of parts subject to wear.
b. Items recommended to be stocked as spare parts.

8. As-installed control diagrams by controls manufacturer.

9. Each contractor's coordination drawings.

a. As-installed, color-coded piping diagrams.

10. Charts of valve tag numbers, with the location and function of each valve.

11. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

12. Other data as required under pertinent sections of specifications.

C. Content, for each electric and electronic system, as appropriate:

1. Description of system and component parts.

a. Function, normal operating characteristics, and limiting condition.
b. Performance curves, engineering data and tests.
c. Complete nomenclature and commercial number of replaceable parts.

2. Circuit directories of panel boards.

a. Electrical service.
b. Controls.
c. Communications.

3. As-installed, color-coded wiring diagrams.

4. Operation procedures

a. Routine and normal operating instructions.
b. Sequences required.

c. Special operating instructions.

5. Maintenance Procedures

a. Routine operations.
b. Guide to "trouble-shooting".
c. Disassembly, repair and reassembly.
d. Adjustment and checking.

6. Manufacturer's printed operation and maintenance instructions.

7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

8. Other data as required under pertinent sections of specifications.

D. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

E. Additional Requirements for Operation and Maintenance Data: The respective sections of Specifications.

END OF SECTION

SECTION 01 91 00

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Commissioning Plan: The Cx Plan outlines responsibilities outside of the construction contract and shall be available to all Parties for reference. It gives the Contractor a perspective with respect to the overall process. It encompasses the entire Cx process including design phase and post construction tasks.

1.2 SUMMARY

A. Section Includes: The Work of this Section shall include but not be limited to the following:

1. Commissioning requirements common to all Sections
2. Systems and equipment ‘Start-Up’ and ‘Functional Performance Testing’
3. Validation of proper and thorough installation of systems and equipment
4. Equipment performance verification
5. Documentation of tests, procedures, and installations
6. Coordination and requirements of ‘Training Events’
7. Preparation and logistics of Systems Manual content
8. Management of record construction documentation
9. Sequencing

B. Related Sections

1. Individual Division 1 Sections: Individual Sections stipulate requirements for project meetings, submittals, closeout procedures, operation and maintenance data, warranties, record documents, training, nameplate data, etc..
2. Section 01 91 10 – Functional Testing Procedures: Outlines ‘generic’ Functional Testing Procedures required for specific system types subject to the Cx process.
3. Individual Specification Sections: Individual Sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.
4. Section 22 08 00 –Plumbing Systems Commissioning: Details the Cx procedures specific to Plumbing Systems work.
5. Section 23 08 00 – HVAC Systems Commissioning: Details the Cx procedures specific to HVAC work.
6. Section 23 08 01 – Building Automation Systems (BAS) Commissioning: Details the Cx procedures specific to the Building Automation System.
7. Section 26 08 00 – Electrical Systems Commissioning: Details the Cx procedures specific to Electrical Systems work.

1.3 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is adequately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process. It expands on the Cx Plan, which covers the roles and responsibilities of Parties outside of the construction contract.

1.4 SCOPE

A. This Section covers elements, requirements, procedures, and protocols common across all Divisions of the work. Requirements specific to individual Sections are generally specified in the technical specification as well as a dedicated Section for each of Divisions 21, 22, 23, 26, and 28.

B. Specific systems to be commissioned are indicated in the following Divisions of the Specification:

1. Divisions 02–12, 14: Conformance to the following provisions of the Cx requirements is required under Division 01 and this Section:
    a. 'Equipment and Systems Training' as required by individual Sections;
    b. Systems Manual preparation and maintenance;
    c. Record Document preparation and maintenance.
2. Division 22 – Plumbing: Requirements for Cx are specified in Section 22 08 00 as well as in individual Division 22 Sections.
3. Division 23 - HVAC: Requirements for Cx are specified in Section 23 08 00 as well as in individual Division 23 Sections.
4. Division 23 – BAS: Requirements for Cx are specified in Section 23 08 01 as well as in individual Division 23 Sections.
5. Division 26 – Electrical: Requirements for Cx are specified in Section 26 08 00 as well as in individual Division 26 Sections.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and final training occurs. This will generally occur after the Construction Phase is complete (after Start-Up Documentation has been completed). The Acceptance Phase begins upon System 'Turn-Over' with certification by the Contractor that the systems have been placed into service in accordance with the approved protocols and after the submission of the approved Start-Up Documentation. The Acceptance Phase ends with the successful completion of all Functional Performance Testing and sign-off by the CxA.

B. Action Item (AI): Any Cx-related issue that requires a response, completion, corrective or additional work, or any other action. Examples include a Request for Information (RFI), a work directive, a clarification request, a to-do item, an identified deficiency, or any other like item. Action Items must be categorized as appropriate.

C. Action List: This is a list that is maintained and updated by the CxA that includes all Action Items that relate to Cx activities.

D. A/E: General reference to the Architect/Engineer lead-design entity.

E. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers.

F. Basis of Design (BOD) Document: The Basis of Design document is developed by the design team, and shall respond to and be consistent with the performance criteria specified in the Owner's Project Requirements. The BOD illustrates the means by which the OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected alternatives. At the end of the project, the final BOD content may be incorporated into the Systems Manual if desired in part or in its entirety. The BOD is a required component for LEED-certified projects, and is recommended by ASHRAE for all projects subject to the Cx process.

G. Building Automation System (BAS): The computer-based control or automation system. BAS is used throughout these Sections. Alternate references common in the industry include facility management system, automatic temperature control system, direct digital control system, building management system, building management and control system, digital control system, Energy Management System, Energy Management and Control System or System Control and Data Acquisition (SCADA) System.

H. Checklist Item: An item to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. Start-Up Checklist items are one component of the Start-Up Documentation.

I. CMMS: Computerized Maintenance Management System

J. Commissioning (Cx): The process of ensuring that all building systems perform interactively according to the design intent, that the systems are efficient and cost effective, and that they meet the Owner's operational needs.

K. Commissioning Authority (CxA): The Party retained by the Owner who will oversee and manage the Cx process, develop and stipulate many of the Cx requirements, and ensure and validate that systems and equipment are designed, installed and tested to meet the Owner's requirements.

L. Commissioning Coordinator (CxC): This refers to the Individual within each of the various Parties that is designated the POC for that Party relative to Cx activities. Each of the Contractors subject to the Cx process should designate a CxC and make that person available to the CxA as the point-of-contact for that Contractor.

M. Cx Portal: See 'Portal' below.

N. Cx Record Matrix: The Cx Record Matrix provides an ongoing and updated status of the cx program as it is being executed. It is a table of all systems and equipment subject to the Cx process and the status and responsible party of Cx procedures relating to that equipment. Typical fields tracked include equipment tag, location, description, Start-Up Documentation status, FPT status, and training status, status of submittals and record drawings, and final Cx disposition.

O. Commissioning Specifications: Generic reference to any of the Cx-specific specification Sections, as inferred by the usage. Divisions 01, 22, 23, 26, and others contain Sections that are specific to or reference the Cx process. All Contractor requirements relating to Cx should be conveyed within the Cx Specs. Cx Specs should be referenced but not duplicated within the Cx Plan (the Cx Plan is designed to govern non-Contractor-related Cx issues).

P. Commissioning Team: The group of Parties involved in the Cx process for any given system. The Cx Team will include a core group involved with all systems, consisting of the CxA and CxC members representing the GC and the Owner. On any given system, the Cx Team will additionally include the CxC's for the Contractors responsible for the system or equipment.

Q. Contractor: As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the GC, subcontractors, or vendors as inferred by its usage.

R. Construction Manager (CM): The Party working with the Owner to advise, coordinate, and inspect the project through design and construction.

S. Construction Phase: Phase of the project during which the facility is constructed and/or when systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete Start-Up Documentation, submit O&M information, establish trends, and perform any other applicable requirements to make systems operational. Contractor and Vendors may also conduct 'Equipment and Systems Training' events during this phase. The Construction Phase concludes upon completed Start-Up and TAB of systems and equipment.

T. Contract Documents: The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):

1. Agreements/Contracts;
2. Construction Plans and Drawings;
3. Specifications;
4. Addenda;
5. Change Orders;
6. Commissioning Plan (for reference only)

U. Construction Documents: Refers generally to the Contract Documents that dictate the details of the installation (all but item a. above).

V. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly or is not complying with the design intent.

W. Design Engineer: Generic reference to the engineer-of-record or a specific engineering disciple as inferred by its usage.

X. Design Intent Document (DID): Outdated term that is synonymous with Owner's Project Requirements (see below). OPR is now used by both ASHRAE and LEED.

Y. Electrical Contractor (EC): Contractor generally responsible for Division 26 work.

Z. Factory-Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.

AA. Factory Testing: Testing of equipment off-site at the manufacturer's facility. May be witnessed by the members of the project team.

BB. Fire Alarm Contractor (FAC): Contractor generally responsible for the fire alarm system installation specified in Section 283100

CC. Functional Completion: A Cx program milestone that marks the successful completion of the FPTs by the CxA and therefore completion of the Acceptance Phase. Functional Completion is a prerequisite for Substantial Completion.

DD. Functional Performance Tests/Testing (FPT): The detailed and thorough tests (and test procedure) developed and performed by the CxA to document proper operation of building systems and the components and equipment making up those systems during the Acceptance Phase. References made to FPT throughout the documents are inclusive of ISFPT unless specifically indicated otherwise.

EE. General Contractor (GC): The Party acting as the primary coordinator of all the major subcontractors (MC, EC, TAB, BAC, etc.) as applicable.

FF. IAQ: Indoor Air Quality

GG. Interactive System Functional Performance Testing (ISFPT): The detailed and thorough testing of the interactions of various systems in the building. ISFPTs are considered a subset of the overall concept of FPT and therefore references made to FPT generally will include ISFPTs unless specifically indicated otherwise.

HH. LEED (Leadership in Energy and Environmental Design): The LEED® Green Building Rating System is a voluntary, consensus-based rating system designed to encourage building owners to apply leading proven technologies for new construction. Areas of concentration include “Sustainable Sites”, “Water Efficiency”, Energy and Atmosphere”, “Materials and Resources”, and “Indoor Environmental Quality”. Contractor activities from demolition to procurement to commissioning to waste handling can be impacted by the LEED program.

II. Manufacturer’s Representative: Either an individual in direct employ of the manufacturer of the applicable system, or an individual who is certified by that manufacturer to perform the applicable work for which the reference is made. This is synonymous with Factory-Authorized Representative.

JJ. Mechanical Contractor (MC): Contractor generally responsible for Division 22 and 23 work.

KK. O&M Manuals: Generic reference to manufacturer-published O&M materials, which have no information specific to the facility, but may be edited or marked up to indicate specific equipment or systems installed. O&M Manuals include documents covering installation, operation, maintenance, troubleshooting guides, parts numbers, engineering and design parameters, applications manuals, and any/all information available from the manufacturer pertaining to the installed equipment or systems. Specifications should strive for this information to be submitted in electronic form whenever possible. The electronic versions of these documents can also be electronically edited to indicate equipment installed and to delete or mask-over equipment and content that is not installed on the project.

LL. Observation Period (BAS): Period of time immediately following Functional Performance Testing where the BAS is shown to operate properly without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications.

MM. Opposite Season: The season opposite that when the majority of the testing occurs.

NN. Owner’s Project Requirements (OPR): The OPR is intended to provide the basis from which all design, construction, acceptance, and operational decisions are made. It details the functional requirements of the project, including systems subject to commissioning. The OPR defines the benchmarks and metrics by which the success of the project is ultimately judged, and evolves through each project Phase. The OPR is typically developed early in the project cycle by the Owner and the A/E and provides the user needs, requirements, goals, and metrics that are defined by the Owner to be important. The OPR criteria are referenced by and should be the foundation of the BOD narrative. At the end of the project, content the final BOD may be incorporated into the Systems Manual. The OPR/BOD is a required component for LEED-certified projects, and is recommended for all projects subject to the Cx process.

OO. Party: Entity (company, corporation, etc.) legally responsible for portion of work.

PP. Point-of-Contact (POC): General reference to a key individual within each Party.

QQ. Portal: The Cx Portal ('Portal') is a Web-based Internet hub used to electronically collaborate and coordinate activities throughout the Cx process. The Portal is hosted by the CxA and is accessible by all Parties participating in the Cx program.

RR. Prefunctional: The term "Prefunctional" is synonymous with "Start-Up", but not used in these specifications. It is a modifier for checks, tests, and other activities that occur prior to and are prerequisites for Functional Performance Testing.

SS. Preliminary Service: Refers to initial operation of a system or piece of equipment to provide temporary service where initial Start-Up to determine safe operation has been performed. Final TAB and Functional Performance Testing proceeds while the system is in Preliminary Service.

TT. Pre-Test: Preliminary testing accomplished to verify system functionality prior to placing the system/equipment into Preliminary Service.

UU. Project Phases: Phases of the project include the Construction Phase, Acceptance Phase, Warranty Phase, and Occupancy. Earlier Phases include Program Phase and Design Phase.

VV. Project Officer (PO): Individual or entity directly employed by the Owner who is in charge of the design and construction coordination for the project. Alternately, the Owner may employ a separate CM to perform this function.

WW. RFI: Request for Information.

XX. Room Data Sheet: The Room Data Sheet is a spreadsheet or database which lists the control and occupancy requirements - including the temperature and humidity setpoints, pressurization, etc. - for each room or control zone in the facility. This list also includes the control range tolerances and the alarm ranges for the zone. Additionally, the Room Data Sheet may include occupancy schedules or lighting control parameters (typical for vivariums and some laboratories) which must be programmed for initial occupancy. This should be updated through the construction process to reflect any changes generated during construction.

YY. Scheduled Outage: A period of time, scheduled by Owner, in which the system is out-of-service or not to be used by occupants.

ZZ. Start-Up: Refers to the quality control procedures whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the 'Start-Up Checklist', energizes the device, verifies that it is in proper working order and ready for dynamic testing, and completes the 'Start-Up Tests'. Start-Up procedures are performed by the Contractor with or without a formal Cx process, although the documentation is more formalized when the Cx process is used.

AAA. Start-Up Checklist: A list of items to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. These include primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension checked, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). Start-Up Checklist items are one component of the Start-Up Documentation (Start-Up Tests being the other).

BBB. Start-Up Documentation: Refers to the combination of Start-Up Checklists + Start-Up Tests. The Contractor documents the Start-Up procedure by completing and submitting the Start-Up Documentation. Start-Up Documentation may be a combination of procedures prepared by the CxA, those included in the Contractors in-house quality assurance process, and those required by the manufacturer. Regardless of the context of the checklist or format of the form used to documents it, the reference to 'Start-Up Documentation' includes all of the stated checklists and tests.

CCC. Start-Up Test: This is a quality-assurance test that is required to ensure the system is ready to be placed into service. It differs from a checklist item in that it requires more than a binary (yes/no, OK/Not OK) response - an observation, measurement, or sequence of events must be documented. Start-Up Tests are one component of the Start-Up Documentation (Start-Up Checklists being the other).

DDD. Substantial Completion: Milestone as defined in the Owner-Contractor agreement and Specifications. This milestone will coincide with the end of the Acceptance Period. This milestone also coincides with the start of the Warranty Period.

EEE. System Turn-Over Meeting ("Turn-Over"): Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the CM and GC, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data is complete and accurate. The CxA will in many cases participate in this. GC shall organize and lead the process in all cases.

FFF. Systems Manual: The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CxA or A/E, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment. The content of the Systems Manual is dictated by budget, and usually consists of a single narrative document with references to and inclusive of the entire set of O&M and Training materials.

GGG. Systems Matrix: A table that lists systems and equipment as individual rows (typically using the specifications sections as a guide) and columns that indicate different tasks, documentation, and work elements. The content of the cells of the matrix summarizes the requirement for system as it relates to that column. It provides and effective summary of requirements that is approved by the Owner and operator representatives during design phase.

HHH. Test: A task, procedure or measurement that confirms capacity, functionality, accuracy, etc. Tests have a status of "Pass", "Fail", "Couldn't Test" or "Didn't Test". May refer to Start-Up or Functional Performance Tests.

III. TAB: Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor as inferred by its usage.

JJJ. Temporary Conditioning Plan: A plan that summarizes the logistics, procedures and protocols for taking permanent equipment and using it to maintain conditions throughout construction. The Temporary Conditioning Plan must be approved by all members of the Cx Team prior to placing equipment into temporary service.

KKK. Testing Agency: An independent agency typically retained by the Contractor to perform specialized testing of systems or equipment (most commonly electrical). The Testing Agency shall be qualified and equipped to perform the testing and shall submit appropriate qualifications.

LLL. Trending: Monitoring and recording a history of parameters typically using the building automation system.

MMM. Turn-Over: See "System Turn-Over Meeting" above.

NNN. Vendor: Refers to the organization that sold a system or equipment to the subcontractor. This may be a branch office of the manufacturer or a value-added reseller.

OOO. Warranty Period: The period defined by the construction documents where elements of the facility are under contractual warranty.

PPP. Warranty Phase: Includes the early occupancy of the building and can continue through the contractual Warranty Period and at least into the opposite season from when the facility systems were initially tested.

QQQ. Zone Airflow Matrix: The Zone Airflow Matrix is a spreadsheet or database that tracks the building supply, return, and exhaust air flow rates on a zone-by-zone basis and sums these values by air handler or exhaust fan, floor, and

building. The purpose of the Zone Airflow Matrix is to ensure that the building pressurization is maintained from minimum to maximum zone flow rates, and that the respective air systems have adequate capacity for the connected terminal loads. The Zone Airflow Matrix is updated throughout the construction process by the A/E to reflect all changes and turned over to the TAB prior to beginning initial balance of the systems.

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 0-120056, "The Commissioning Process"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB - Procedural Standards for Building Systems Commissioning

D. ASHRAE Standard 110 – Method for Testing Laboratory Fume Hoods

E. NSF 49 – Class II Biosafety Cabinetry

F. USGBC - LEED New Construction and Major Renovation Reference Guide (Version 2.2)

G. USGBC - LEED Existing Buildings Reference Guide (Version 3.0)

H. SMACNA IAQ Guidelines for Occupied Buildings Under Construction

1.7 DOCUMENTATION

A. Contractor shall provide the following documentation to the CxA per the procedures specified herein and in other Sections of the specification:

1. Shop Drawings and Product Data: CxA shall be provided shop drawings and submittal data for systems and equipment that will be part of the Cx process. Some of these submittals will be reviewed by the CxA and others are only needed for record. CxA will mark up the Submittal Register to indicate the documents required. Electronic format shall be in PDF format and shall be capable of allowing electronic comments and markups.

   a. Submittals to be Reviewed: GC shall provide the CxA one electronic copy of Shop Drawings and Product Data concurrent with distribution to the A/E. CxA shall review and incorporate comments via the A/E. GC shall then copy CxA with the final reviewed submittal with A/E approval stamp.

   b. Submittals for Record: GC shall provide to the CxA the final electronic record copy of the submittal.

2. Draft Start-Up Documentation: Contractor shall develop Start-up Documentation for all applicable equipment and systems along with the manufacturer’s application, installation and recommended start-up procedures. CxA will initially provide to the Contractor generic Start-up Checklists, the content of which must be reviewed by the Contractor and supplemented with manufacturer-specific requirements and the Contractor’s own internal quality assurance procedures and checks. CxA will review draft and recommend approval.

3. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase.

4. Schedule Updates: Issue periodic updates to the construction schedule as specified. Provide electronic copy of each update to the CxA. Contractor shall use schedule updates to notify Cx Team of scheduled start-up and training activities.

5. Temporary Operating and Conditioning Plan: Contractor shall provide initial Temporary Operating and Conditioning Plan for approval and then issue periodic updates to reflect actual conditions. At the completion of the temporary conditioning period, the final plan shall be submitted with completed maintenance records, inspection and check logs, operating logs, and narrative of any problems or issues that occurred during Temporary Conditioning (if applicable).

6. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide Piping Cleaning, Flush, and Fill Plan for approval at least 30 days prior to final cleaning, flush, and fill.
7. Action Item Response: Respond to Action Items to which the CxA assigns responsibility to the Contractor.
8. Field Testing Agency Reports. Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase.
9. Completed Start-Up Documentation: Provide completed Start-Up Documentation for all applicable equipment and systems. Provide prior to the start of the Acceptance Phase. CxA will review prior to FPT. Completed Start-Up Documentation shall be entered by the Contractor on the Portal.
10. Nameplate Data Documentation: Provide prior to the start of the Acceptance Phase. completed nameplate data shall be provided by the Contractor in electronic format.
11. Equipment Warrantees: Provide prior to the start of the Acceptance Phase.
12. Training Plan: Provide prior to the start of the Acceptance Phase.
13. Record Training Documentation: Provide at least 7 days prior to the start of the applicable training session. The compiled and final record training documentation will be provided by the GC within 14 days of the last training session provided under the construction contract (this will typically be the site-specific controls training). This will take the form of the Training Plan supplemented with evaluations and actual dates and topics.
14. O&M Documentation Content: Provide O&M Documentation content (including installation-specific instructions) to the CxA for incorporation into the Systems Manual per the requirements of this Section, and Division 01 requirements. Submit at least one month prior to the beginning of the Acceptance Phase.

B. Record Drawings: Contractor shall maintain an updated set of record or ‘As-Built’ documents at the jobsite reflecting actual installed conditions and all approved changes and modifications to the contract documents. Contractor shall provide access to the CxA to review the As-Built and Record Drawings. Provide Record Drawings in accordance with Division 01.

1.8 COMMISSIONING SEQUENCING AND SCHEDULING

A. Refer to the sequencing illustration at the end of this Section for a conceptual graphical representation of the precedents related to the Cx tasks. These precedents are generally to be applied per system and/or per area. Where applicable, in order to expedite the closeout of the facility, various systems can be in various stages of the Cx process. CxA and Contractor shall cooperate to schedule the Cx tasks to minimize the duration of the Cx activities.

B. The Cx process will be categorized into Phases as indicated below and defined under the definitions paragraph above. Note that per schedule, different systems and/or areas may be in different phases at any given time given that the Cx program will be integrated into the construction process:

1. Construction Phase
2. Acceptance Phase
3. Warranty Period

C. CxA will provide a more detailed precedent diagram in Excel format for direction of Cx precedents and task duration.

D. Prior to submission of the baseline schedule, the scheduler will coordinate with the CxA to specifically include the detailed tasks involved in the Cx process. CxA will provide an initial “Precedent Diagram” that outlines the optimal Cx process. Scheduler shall meet with the CxA and the subcontractors to synthesize the Precedent Diagram with the general construction process constraints and integrate the agreed upon process into the main construction schedule.

Commissioning-related tasks shall be coded as such to facilitate generating a Cx fragnet that will be used during Cx progress meetings.

E. The Cx precedent schedule will outline generic Cx tasks with precedents or prerequisites to each task. These tasks, which will be shown generically for typical systems, will apply to many systems. Contractor shall incorporate the tasks into EACH SYSTEM. This will require a detailed track for each system and as such the scheduler must schedule and code by system as well as by area. The Cx precedent diagram will also indicate system precedent requirements for start-up and Functional Performance Testing. Contractor shall collaborate with the CxA to determine impacts of project phasing as applicable. Examples of enumerated tasks include:

1. Contractor preparation of draft Start-Up Documentation;
2. Contractor preparation of Training Plan;
3. Preparation of O&M Documentation content and other content for the Systems Manual;
4. Testing Agency activities;
5. Electrical Start-Up by system and zone group;
6. Mechanical Start-Up by system and zone group;
7. BAS Start-Up by system and zone group;
8. TAB by system and zone group;
9. Training Events;
10. Functional Performance Testing by system and zone group;

F. Contractor shall completely install; thoroughly inspect; start-up; and test, adjust, and balance systems and equipment. All activities shall be documented per specified procedures and progress tracked on the construction schedule.

G. Contractor shall notify CxA at least 14 days in advance for all system and equipment Start-Ups, training, pressure tests, or system flush and fill. At their discretion, the CxA shall witness selected Start-Ups, training events, or tests. Notification shall be accompanied by a schedule showing the coordinated start date and task duration and all currently open precedent requirements.

H. GC shall schedule and conduct System Turn-Over Meetings for all systems and equipment in the Cx scope as specified below. GC shall notify CxA, CM, A/E, and Owner in writing that systems are complete and ready for verification and Functional Performance Testing.

I. Notification of utility or system outages affecting current mission shall require advance notification per applicable Division 01 section.

J. Connections to or Interruptions of Existing Systems: Where the project entails connection to or interruption of existing functional systems that are supporting the Owner's mission, such connection activities must be shown as a milestone on the project schedule. Generally these connections will require extensive coordination and a long period of pre-notification as defined in Division 01. Owner will not accept these connections unless the connection or outage is shown as a milestone 3 months prior to the event. The schedule will not be required to pinpoint the day and time 3 months in advance, however, it shall have been accurate to +- 2 weeks. The actual notification of the exact day and time shall be processed per applicable Division 01 section.

1.9 SYSTEM TURN-OVER MEETINGS ('TURN-OVER')

A. GC shall schedule and conduct System Turn-Over Meetings ('Turn-Over') for all systems and equipment. Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the CM and GC, meet to validate that the system or equipment is completed and operational per th

e contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data has been completed and is accurate. The CxA will in many cases participate in this. GC shall organize and lead the process in all cases.

B. Notification shall be given of all System Turn-Over Meetings to the CxA and the Owner via an Action Item posted on the Portal at least 14 days in advance of the activity. CxA and Owner may elect to witness the Turn-Over, although it is not required. Primary responsibility of confirmation of the represented state of the equipment lies with the GC.

1.10 ELECTRONIC RECORD SUBMITTALS AND O&MS

A. Contractor shall submit a final electronic version of the submittal for Owner's future asset management within 14 calendar days after receipt of approval from the Owner and the Architect on any submittal for equipment in Divisions 11, 13, 21, 22, 23, 25, 26, and 28.

B. Final Electronic Record Submittals shall:

1. Be originally authored in electronic media and not scanned versions with hand mark-ups unless specifically approved otherwise.

2. Be provided in Portable Document Format (*.pdf) with selectable text and graphics that are readable. The documents shall use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic if the submittal exceeds 25 pages.

3. Include all final ratings, parameters, specifications, options, etc. In the case where the Architect returns the submittal "Approved As Noted, Resubmission Not Required" and includes mark-ups or comments that change the originally submitted ratings, parameters, specifications, options, etc., the Contractor shall correct the documents in the original electronic document prior to submitting the final electronic documents.

4. Highlight the specific rating, parameter, specification, option, etc. when the original document includes multiple alternatives. For instance, when a range of performance parameters are given or various sizes are shown, or various options are listed, the applicable item shall be indicated by highlight, circle, pointer, or other electronic marking. Partial-page material in the submittal that does not pertain to the project can be masked with a transparent gray screen over the text; entire pages that are not applicable may be electronically deleted.

5. Do not include generalized direction from the Architect that does not relate to ordering and purchasing the equipment. For instance, notes such as "Coordinate with mechanical engineer for final motor horsepower" are not to be transferred to the electronic submittal. In that example, only the final coordinated sizes shall be indicated.

C. Contractor shall submit a draft electronic version of the O&Ms to the CxA for format review prior to the Acceptance Period for equipment in Divisions 11, 13, 21, 22, 23, 26, and 28. The O&Ms shall include the content described later in this section and the Record submittals. Final O&Ms shall be submitted prior to Substantial Completion.

D. Final Electronic O&Ms shall:

1. Be originally authored in electronic media and not scanned versions with hand mark-ups unless specifically approved otherwise.

2. Be provided in Portable Document Format (*.pdf) with selectable text and graphics that are readable. The documents shall be merged into one bookmarked document up to 500 MB. Merged documents shall use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic. For submittals larger than 500 MB, provide a summary document in PDF or HTML format with relative hyperlinks to the associated document files within the same directory or in directories subordinate to the summary document.

3. The O&Ms shall be project specific and include edit marks, clouds or highlights, to indicate only those models of the equipment which were provided as part of this Contract. Similarly, the O&Ms shall include edits to mark out content that does apply to equipment provided as part of this Contract.

E. Final Electronic Record Submittals and the O&M Manual shall be either posted to the project web site or provided on compact disc.

1.11 COORDINATION MANAGEMENT PROTOCOLS RELATIVE TO COMMISSIONING

A. Coordination responsibilities and management protocols relative to Cx are initially defined Contractor shall have input in the protocols and all Parties will commit to process and scheduling obligations. The CxA will record and distribute.

1. Submittals and Shop Drawings: GC shall distribute these to the CxA. CxA shall edit the project's submittal log to communicate which submittals must be forwarded to CxA.

2. CxA Review Comments on Shop Drawings: Comments shall be posted on the Portal and a copy sent directly to the A/E and PO by the CxA. A/E shall consider and incorporate at their discretion.

3. Deficiencies Identified by the CxA: When the CxA identifies a deficiency, CxA shall make a good faith assessment of responsible parties. Those parties, as well as PO and GC shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a directive to any party to resolve the deficiency. Contractor may accept responsibility and resolve the deficiency voluntarily. If Contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Cx dialogue, PO shall issue a work directive or RFI via the normal contractual channels to resolve the issue.

4. Requests for Meetings: Request by the Contractor for a meeting with the CxA shall be routed through GC who will then determine the validity. Note that every attempt should be made to deal with Cx issues at regularly scheduled Cx Meetings.

5. Control Sequence Modifications: CxA shall make every attempt to thoroughly review the sequences during the submittal phase and address any issues prior to the submittal approval. However, CxA and the BAC may incorporate minor changes to the sequence during testing when it is apparent that it improves the control of the equipment but does not fundamentally change the sequence. The time required by the BAC for this type of modification is addressed in Section 23 08 00. Any and all changes must be thoroughly documented in the record documents.

6. Scheduling Coordination: CxA shall consult directly with the GC to incorporate the Cx tasks in the project schedule. The process logic and integration shall ultimately be a collaboration between GC, CxA, and subcontractors. The effort will start with CxA and GC proposing initial logic. Then subcontractors will join the discussion and work out the final details, (precedent logic and durations).

7. Notification of Completion Milestones: Contractor shall notify GC at least two weeks prior to an anticipated Cx activity or milestone (such as Turn-Over). GC shall then coordinate the scheduling of the activity (as applicable) between all required parties as applicable. Notification shall be posted using the Portal (events module) with an associated Action Item distributed to interested parties.

8. Action List: CxA maintains a categorized Action List which tracks the Cx-related action items. All content of the Action List will be available to all parties who have credentials on the Portal. Any party with credentials may post an Action Item. Any party that is copied on an email resulting from an Action Item posting may respond to it and contribute to the dialogue.

9. Start-Up Checklist and Test Documents: CxA will provide initial 'generic' Start-Up Documents to the Contractor. The Contractor shall synthesize these with the manufacturer-specific start-up procedures and submit both to the

CxA for review and approval. The Contractor has the option of modifying the supplied generic procedures in the delivered format, or by supplementing these with their own procedures. The Contractor then executes, signs, and submits the final reviewed and approved Start-Up Documentation. The CxA subsequently (and optionally) spot-checks the procedures and documentation at the 'System Turn-Over Meeting'. The Start-Up Documentation is then included in the Commissioning Record.

10. Functional Performance Test Documents: Functional Performance Tests are prepared and completed by the CxA. They are developed during the construction phase, typically after completed submittals. CxA forwards the FPT procedures to the GC to be subsequently distributed to the Contractors for review. Contractors approve the procedures. Throughout the Cx process, CxA maintains a current record of the FPTs and their results and keeps the documentation up to date and accessible for all to access the current progress. CxA distributes hard copies of the FPTs at the completion of any significant stage of commissioning.

1.12 CONTRACTOR RESPONSIBILITIES

A. Construction Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Construction Phase.

1. Include Cx requirements in price and plan for work.
2. Designate a Commissioning Coordinator (CxC) from each major subcontractor with activities related to commissioning. These Commissioning Coordinators are to be the primary contacts for Cx activities.
3. Attend Construction Phase Cx Kick Off Meeting. The CxC and Project Manager from each major subcontractor shall attend.
4. The CxC's shall attend all Cx progress meetings unless otherwise agreed to by the CxA.
5. Remedy any deficiencies identified throughout construction.
6. TAB shall submit sample balancing forms for approval prior to starting work.
7. Schedule and coordinate Cx efforts into the construction schedule. Incorporate the precedent diagram provided by the CxA into the construction schedule. Indicate at a minimum all tasks enumerated on the precedent diagram for all systems.
8. Coordinate the work of subcontractors, vendors, manufacturers, and Testing Agencies provided with the bid, and ensure that they are informed of and are adhering to the requirements of the Cx process specified throughout the contract documents.
9. Contractor-Developed Documentation: Contractor shall develop and submit the following information as specified:
    a. Draft Start-Up Documentation (submit along with the manufacturer's application, installation and start-up procedures);
    b. Systems Manual content as specified;
    c. Training Plan, and materials and documentation of training;
    d. Temporary Operating and Conditioning Plan, if applicable, content as specified;
    e. Piping Cleaning, Flush, and Fill Plan, content as specified;
    f. Comprehensive integrated procedures for scheduling and task notification and documenting them in a common format.
10. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review test procedures to ensure feasibility, safety and equipment

protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.

11. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.

12. Start-up, test, adjust, and balance systems and equipment prior to verification and Functional Performance Testing by the CxA. Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically individual Cx specifications. Provide skilled technicians qualified to do the work required. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Start-Up and Functional Performance Testing shall proceed from device checkout, to component checkout, to system checkout, to inter-system checkout.

13. Prepare spaces with adequate security for on-site contractors to store equipment. Provide secure space with 120 volt AC power for the CxA, TAB, and BAC to base their operations and store test equipment, drawings, files, and the like.

14. Schedule for any required representative space mock-ups as early as possible to facilitate determining standards for closeout.

15. Record Start-Up procedures on approved Start-Up Documentation and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the party actually performing the task or procedure.

16. Provide skilled technicians qualified to perform the work required.

17. Provide factory-trained and authorized technicians where required by the Contract Documents.

18. Tag equipment that is started with the Individual's name and date.

19. Demonstrate the operation of all systems as specified.

20. Certify that systems have been installed and are operating per Contract Documents prior to Functional Performance Testing.

21. Maintain an updated set of Record Documentation as required by the Contract Documents.

22. Copy the CxA on indicated documentation.

23. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to general contract requirements (Division 1) and to each piece of equipment or system.

B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.

1. Assist CxA in Functional Performance Testing. Assistance will generally include the following:

   a. Manipulate systems, equipment, BAS, and other control systems to facilitate testing (as dictated in Section 01 91 10 ; in most cases this will entail only an initial sample).

   b. Provide any specialized instrumentation necessary for Functional Performance Testing.

2. Correct any work not in accordance with Contract Documents.

3. Participate in Training Events relative to use of O&M information and the preventative maintenance program.

4. Maintain record documentation, and update and resubmit it when Acceptance Phase is completed.

5. Compensate CxA for additional site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing.

C. Warranty Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Warranty Phase.

1. Provide warranty service;
2. Conduct Final Systems Operation Training (BAC lead);
3. Respond to and document warranty issues;
4. Participate as required in opposite season testing;
5. Correct any deficiencies identified throughout the Warranty Phase;
6. Update record documentation to reflect any changes made throughout the Warranty Phase and resubmit final Record Drawings at the close of the Warranty Phase.

1.13 EQUIPMENT SUPPLIER/VENDOR RESPONSIBILITIES

A. Construction Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Construction Phase.

1. Provide shop drawings and product data in hard copy and electronic format.
2. Provide manufacturer's application, installation and start-up instructions within 30 days of shop drawing/product data approval.
3. Where factory-authorized start-up is specified, coordinate and participate in the specified Cx process and document start-up on the appropriate forms.
4. Review and approve Functional Performance Test procedures affecting supplied equipment.
5. Where training is to be provided by factory-authorized personnel, provide required Training Plan information including course content for approval prior to conducting the training.
6. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to general contract requirements (Division 1) and to each piece of equipment or system.
7. Provide spare parts and materials as required by the specifications.
8. Provide special tools as required by the specifications.
9. Provide Systems Manual content as required and develop project-specific O&M content as required by the Cx requirements.
10. Provide all warranties.

B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Acceptance Phase.

1. Participate in any Functional Performance Testing required.
2. Consult on issues identified relative to the supplied equipment.

C. Warranty Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Warranty Phase.

1. Provide any warranty service required to the supplied equipment as applicable with the agreement with the Contractor.
2. Maintain Systems Manual content relative to supplied equipment.
3. Provide technical support to the Owner's facilities personnel.

1.14 COMMISSIONING KICK OFF/COORDINATION MEETING

A. CxA shall schedule and conduct a Cx coordination meeting near the beginning of construction. The following should be discussed at this meeting:

1. The commissioning documents (specifications and Cx Plan);
2. Requirements and sequence of commissioning;
3. Responsibilities of the construction parties;
4. Management protocols;
5. Required submittals;
6. Schedule

1.15 START-UP DOCUMENTATION AND START-UP PROCESS

A. Purpose: The Cx process requires that the normal quality control processes involved with preparing systems and equipment for operation are performed to a high standard of care and are thoroughly documented. The required Cx-related Start-Up Documentation involves nothing additional than that which would be done for any good installation. These procedures shall be performed to all installed systems and equipment and no sampling strategy is used for the Start-Up process. The Cx process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-Up Documentation that is developed by the joint effort of the Contractor and the CxA.

B. Creation of Start-Up Documentation: Start-Up Documentation (consisting of checklists and tests as defined above) shall be developed by the Contractor and appropriate manufacturers for each type of equipment and system being installed for this project. It shall be submitted to the CxA for approval prior to actual equipment Start-Up. Contractor shall develop Start-Up Documentation based upon a combination of (i) the 'generic' procedures prepared by the CxA (see below); (ii) existing procedures and checklists included in the Contractors in-house quality assurance process, and (iii) those procedures required by the manufacturer. Contractor shall provide the CxA with either 4 hard copies or one electronic copy of manufacturer's application, installation and start-up information at the time they submit the Start-Up Documentation. The CxA shall then approve the Start-Up Documentation. Approved Start-Up Documentation shall reflect all project-specific values, settings, targets, acceptance criteria, and other parameters as appropriate. Final approved Start-Up Documentation shall be entered on to the Portal by the Contractor.

C. 'Generic' Start-Up Documentation: Refer to Sections 23 08 00 and 26 08 00 for 'generic' Start-Up Documentation for a variety of HVAC, mechanical and electrical systems. The content of the 'generic' Start-Up Documentation shall provide the minimally acceptable content. Generic refers to the fact that these procedures and protocols are common for most types of equipment and systems across different manufacturers. The Contractor is responsible for customizing this material to reflect the actual equipment and systems selected.

D. Manufacturer/Vendor Installation and Start-Up Documentation: Contractor and Vendors shall provide manufacturer's preprinted and standard installation checklists, forms, and protocols both for review early in the construction process and to as required to document the Start-Up process towards the end of the Construction Phase. After the approval of the shop drawings and product data, Contractor shall submit manufacturer's start-up procedures and application

guidelines for all systems, equipment, and components. These shall be submitted in electronic PDF format for review and approval. Submittal of the information shall be within 30 days of the submittal approval.

E. Content of Start-Up Documentation: Start-Up Documentation shall generally include the following for each item of equipment or system (as applicable):

1. Project-specific designation, location and service;
2. Indication of the Party performing and documenting the Start-Up;
3. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measured parameters (as applicable);
4. Include a checklist item indicating that all O&M Documentation, Warranties, and Record Documents have been completed and submitted;
5. Include a Start-up Checklist item indicating that proper maintenance clearances have been maintained;
6. Include a Start-up Checklist item indicating that special tools and/or spare tools required for normal operation and maintenance were turned over to the Owner;
7. Include Start-up Checklist item indicating that all required dependent or prerequisite equipment and systems were previously started successfully.

F. Manufacturer's Requirements: Start-Up Documentation shall incorporate all manufacturer-specified procedures. As applicable, include acceptance criteria specified therein. The manufacturer's start-up and checkout procedures shall be submitted to the CxA along with the Contractor's draft Start-Up Documentation.

G. Recording and Documentation of the Start-Up: Manufacturer's start-up protocols shall be executed and forms shall be completed by a qualified/authorized technician. These shall be developed and submitted electronically or at the discretion of the CxA they may be scanned and submitted electronically. Electronic documentation of manufacturer's start-up protocols shall be linked into the applicable test on the Portal.

H. Recording and Completion of Start-Up Checklists and Tests: A qualified technician from the responsible installing Contractor or manufacturer's start-up technician shall document the Start-Up on the approved Start-Up Documentation forms. The individuals executing the Start-Up shall acknowledge acceptability of each item with the indication of who performed the associated task. The Start-Up is not considered complete until the Start-Up Documentation has been completed and entered electronically on the Portal. Information documented manually on paper in the field and/or installation or start-up information developed by the manufacturer must be transferred to the electronic file before Turn-Over can be scheduled. The completed documentation shall be presented and reviewed at the System Turn-Over Meeting.

I. CxA Review: CxA shall review the completed and submitted Start-Up Documentation and request any incomplete data or additional information required to meet the Cx program criteria. CxA will also review and spot-check procedures during Functional Performance Testing.

J. Systems Subject to Start-Up Documentation and Turn-Over: All (100% of) systems shall undergo a documented Start-Up per the approved procedures and NO sampling strategy is used. Completed Start-Up Documentation for all pieces of equipment shall be submitted to CxA prior to Turn-Over or any associated Functional Performance Testing. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.

K. Owner Access: Contractor shall allow access by Owner representatives at any time to inspect the equipment and ensure its proper operation. Owner will be allowed to affix service tags to equipment to track the proper maintenance.

1.16 MECHANICAL-SPECIFIC DOCUMENTATION REQUIREMENTS

A. The Division 23 Contractor shall provide the following documents as specified in Section 23 08 00:

1. Piping Cleaning, Flush, and Fill Plan

2. Temporary Operation and Conditioning Plan (if permanent systems are to be used to condition the building during Construction Phase)

1.17 EQUIPMENT NAMEPLATE DATA

A. Contractor shall provide as-installed specific product nameplate data, product numbers, serial numbers, and other information required to fully define the asset for Owner's use in maintenance management and asset tracking. This data shall be provided electronically to ease in the data transfer to the computerized maintenance management system.

1. Acceptable forms of electronic submittals are:

a. Microsoft Excel spreadsheet arranged with a separate 'Sheet' for each type of equipment and with individual pieces of equipment entered as rows and the applicable values to be recorded as column headings.

b. Microsoft Access database arranged with a separate 'Table' for each type of equipment and with individual pieces of equipment entered as rows and the applicable values to be recorded as fields. Field formats will be as determined at the Construction Phase Commissioning Kickoff Meeting.

c. Text document formatted as Comma Separated Values (csv) with a separate file for each type of equipment, the first row including the field or column names and subsequent entries for each individual piece of equipment as rows.

d. Via the Cx Portal - Nameplate Data Module (if made available by the CxA).

2. Minimum nameplate data content shall include the following as applicable:

a. Construction document designation;

b. Owner's designation if different than the construction document designation and if provided by the Owner;

c. Contact information identification which shall reference the project's Contact List for installing contractor, vendor or representative, and manufacturer. Contractor shall also provide identification for suppliers of parts if different from the previous parties.

d. Model Number;

e. Serial Number;

f. Date of Manufacture;

g. All performance and sizing data required to operate, diagnose, or replace the system, equipment, component or systems with as a minimum that indicated in the construction documents.

h. General description or type classification of the system, equipment, component, or device.

B. Contractor shall provide Equipment Nameplate Data for all equipment provided as work of this Division.

1.18 FUNCTIONAL PERFORMANCE TESTING

A. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the documented OPR/Basis of Design and Contract Documents. Functional Performance Testing facilitates bringing the systems from completed Start-Up to Functional Completion. During the FPT, areas of deficient performance are

identified and corrected, improving the operation and functioning of the systems. System parameters are further tuned and optimized to provide for stable control and interrelated system effects are also addressed.

B. The logistics and procedures involved in Functional Performance Testing are outlined below and in Section 01 91 10.

1.19 DEFICIENCIES IDENTIFIED DURING FUNCTIONAL TESTING

A. Non-Conformance Deficiencies. Non-conformance deficiencies identified during Functional Performance Testing shall be resolved as follows:

1. The CxA will record the results of the functional test in the project database on the Portal. All deficiencies or non-conformance issues shall be noted as Action Items and reported to the Owner and GC.

2. Corrections of identified minor deficiencies may be made during the tests at the discretion of the CxA. In such cases, both the deficiency and associated resolution will be documented in the database.

3. Every effort will be made by the CxA to expedite the FPT process and minimize unnecessary delays, while not compromising the integrity of the procedures.

4. As tests progress and a deficiency is identified, the CxA will discuss the issue with the executing Contractor.

a. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:

1) The CxA shall document the deficiency along with the Contractor's response and intentions, and then proceed forward to another test. A copy/email of the deficiency shall be generated and provided to the Contractor and CxA. The Contractor shall then correct the deficiency, complete the Action Item response certifying that the issue is resolved and /or the equipment is ready to be retested, and sends it back to the CxA.

2) The CxA reschedules the test and the test is repeated until satisfactory performance is achieved. CxA then closes the Action Item.

b. If there is a dispute about a deficiency, regarding whether it is a deficiency and/or who is responsible:

1) The deficiency shall be documented as an Action Item with the Contractor's response and the GC and PO will be notified. The GC will track this issue under the construction contract dispute resolution provisions.

2) Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.

3) The CxA documents the resolution to the Action Item.

4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved. CxA then closes the Action Item.

B. Cost of Retesting: The cost for the CxA to retest a Start-Up or Functional Performance Test shall be paid by the Contractor responsible for the deficiency. Owner shall pay the CxA directly and back charge the responsible Contractor.

C. Failure Due to Manufacturer's Defects. If 10% or three, whichever is greater, of identical pieces of equipment fail to perform to the required Contract Document criteria (mechanically or substantively) due to manufacturing defect, all identical units may be considered unacceptable by the Owner. (For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.) In case of failure due to manufacturer's defects, the Contractor shall provide the Owner with the following:

1. Manufacturer's response in writing as to the cause of the failure and proposed resolution.

2. Manufacturer shall implement their proposed resolution on a representative sample of the product.

3. The Owner will determine whether a replacement of all identical units or a repair is acceptable.
4. Upon acceptance, the manufacturer shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
5. Manufacturer or Contractor shall pay the costs of all retesting necessitated by the failure.

1.20 OBSERVATION PERIOD FOR BAS STABILITY

A. General: The Observation Period is defined as the period of time immediately following Functional Performance Testing where the BAS and the mechanical and electrical systems are shown to operate properly without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications.

B. Prerequisites: The CxA will determine when the BAS has been substantially completed to allow for the start of an informal Observation Period as defined above. Observation Period may be witnessed in phases only on larger more complex projects where interdependencies between phases are not a factor.

1.21 TRAINING EVENTS

A. General: Adequate and thorough training of the Operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Cx program is to ensure that this is accomplished. Contractors, subcontractors, and Manufacturers/Vendors as specified shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible. The Contractor shall be responsible for insuring all training is performed in accordance with the Contract Documents.

B. Training Events Overview. Training Events include all classroom and field-based training sessions that result in the training or transference of design team or Contractor knowledge to the Owner. The following Training Events shall be executed as part of the Training Program:

1. Design Orientation Training: The purpose of the one-time Design Orientation Training event is to acquaint the Owner and Contractors with the facility design strategies and approach taken by the Design Team. The mechanical design engineer is responsible for conducting and documenting this training, with assistance and support from the CxA. Material from the Owner's Project Requirements and Basis of Design Documents shall be covered during this training. An overview of the facility and its systems, the system design goals and the reasoning behind the selection of the equipment will be reviewed. The CxA will also review the upcoming Start-Up process and FPT/Acceptance Testing procedures. An optional tour will be provided at the conclusion of the event.
2. Equipment and Systems Training: The Contractor (or Manufacturer's Representative) shall provide training to the Owner/Operators on individual systems and equipment only after successful Start-Up. These training events cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. Details and required content are provided elsewhere in this Section.
3. Final Systems Operation Training: The BAC shall provide this training to the Owner and Operators on whole-building operation. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion.

C. Training Means, Methods, and Documentation: The Contractor must document all training sessions. Details on the means and methods for conducting and documenting training, including location requirements, preparation, methods for presentation, scheduling, instructor qualifications, and other details are specified below and detailed in the general requirements (Division 1).

1. Setting: Training sessions should typically start and end in a classroom setting. Field demonstrations shall be conducted to demonstrate the hands-on aspects of the required tasks.
2. Presentation: Training shall include electronic presentation materials. Presentation materials shall be submitted by the Contractor with the Training Plan. Contractor shall provide audio/visual equipment as required to communicate to a minimum of 10 attendees.
3. Documentation: Subcontractors or Vendors must document the training sessions in a Training Record. Beyond that included in the Training Plan, documentation shall include the names of the attendees and their evaluations. Training shall follow handouts that list the key points in bullet form presentation style or follow detailed written documentation. Training will not be approved unless it contains accompanying handout documentation to every attendee for their own use and record, separate from the master copy for the Training Record. All documentation must be provided in PDF electronic format. All handouts and presentation slides shall be included in the documentation.

D. Training Plan Document

1. The Training Plan shall outline the various Equipment and Systems Training events and Final Systems Operation Training event as proposed by the Contractors, and shall be approved by the CxA. Contractor shall compile the individual training agendas of the subcontractors and vendors and submit a comprehensive Training Plan to the CxA, Architect and the Owner for review. Training Plan shall summarize all Equipment and Systems Training events with topics to be covered and approximate training duration.
2. The Training Plan shall include at a minimum:
    a. Topic and applicable specification section;
    b. Scheduled date(s) for the Events(s);
    c. Location and setting (classroom or field);
    d. Lead instructor and instructors qualifications;
    e. Co-instructors and their qualifications;
    f. Training objective;
    g. Event outline/agenda;
    h. Detailed breakout of content to be presented;
    i. Anticipated duration;
    j. Required attendees for each session.
3. Review: Contractor shall submit the Training Plan to the GC, who will then disseminate it for review to the Cx Team. Contractor shall incorporate comments and requirements resulting from the review and resubmit the Training Plan prior to conducting any training sessions.

E. Training Prerequisites: Equipment and Systems Training (“Training”) shall not be conducted until the subject system or equipment has completed Start-Up Documentation requirements and Turn-Over. If the Contractor wishes to schedule both Turn-Over and Training on the same day/visit and if the systems are discovered to not be fully-functional at that time, Training shall be canceled and rescheduled.

F. Equipment and Systems Training – Description and Content

1. Description: Equipment and Systems Training events will typically occur over a period of time as systems and equipment are brought online and Turned-Over. Training shall cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions

shall use the manufacturer's printed installation, operation and maintenance instruction material and shall include a review of these instructions emphasizing safe and proper operating requirements and preventative maintenance. Training shall follow handouts that list the key points in bullet form presentation-style or follow detailed written documentation. Training will not be approved unless it contains accompanying written documentation.

2. Equipment Covered: Training shall be provided for all major items of equipment within the scope of commissioning and per the Specifications.

3. Minimum Training Content: Equipment and Systems Training shall include as a minimum for each type of equipment:

   a. Presentation of the equipment within the context of this facility. Typically, the responsible subcontractor shall provide this introduction to the session. The trainer shall review how the equipment serves this specific facility. Information shall include equipment amounts, numbers, capacities, sizes and locations and shall show the equipment in applicable system schematics.

   b. Conceptual overview of how the equipment works;

   c. Names, addresses, phone numbers, websites of sources for information, tools, spare parts, and other details for the equipment;

   d. Details of the warranty or guarantee;

   e. Intended sequences of operation in all modes of operation;

   f. Limits of responsibility (example: unit-mounted controls vs. BAS);

   g. Sources of utility support;

   h. Routine operator tasks involving monitoring and operation, covering all modes of operation and mode switching as applicable;

   i. Relevant health and safety practices/concerns;

   j. Common problems and their diagnosis and repair;

   k. Proper maintenance schedules, tasks and procedures with demonstrations;

   l. Emergency response, documentation and recovery procedures.

4. Scheduling: These events shall be coordinated through and scheduled by the GC.

5. Attendees: Contractor shall insure that all appropriate subcontractors be present for these sessions. Any Cx Team member is eligible to attend. Required attendees include the applicable Contractors (Lead), CxA, and the Owner/Operator.

G. Final Systems Operation Training

1. Description: Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CxA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CxA or the Owner.

2. Coordination with BAS Training: Detailed BAS component training for the facility Operators shall be considered as part of Equipment and Systems Training. This training shall have been completed prior to Final Systems Operation Training.

3. Scheduling: Final Systems Operation Training shall be conducted after all FPTs have been successfully executed.

4. Attendees: Any Cx Team member is eligible to attend. Required attendees include the BAC (lead), CxA (assist), GC, mechanical contractor, A/E, and Owner/Operators.

1.22 SYSTEMS MANUAL PREPARATION AND LOGISTICS

A. Definition: The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CxA or A/E, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment.

B. Systems Manual Lead Developer Responsibilities: The lead developer of the Systems Manual for this project shall be the CxA. The lead developer is responsible for organizing and producing the Systems Manual and for managing the content and contributions from the Parties responsible for providing technical content. The Party responsible for each topic shall assemble, author, develop, coordinate, or otherwise produce the content for that topic as specified below and provide to the lead developer. Requirements as specified include requiring the applicable Contractors to author project-specific information in a consistent format in addition to submission of standard pre-printed manufacturer's O&M and product information.

C. Systems Manual Contractor Responsibilities: Contractor, Subcontractors and Vendors/Factory Representatives shall prepare, organize and submit applicable content for the comprehensive and coordinated Systems Manual as specified below. Some of the material required from the Contractors will need to be authored or customized specifically for this project and facility. Contractor content is indicated by "[GC]" who is responsible for consolidating the content and materials from the various individual Contractors. Content for one system and all associated equipment must be organized and made in one submission. However systems may be submitted separately based on the progress of the project. Each submission shall be indexed as a sub-entity to the overall Systems Manual submission.

D. Division 22 and 23 Contractor Responsibilities: The Division 22 and 23 Contractor shall compile and organize the content for all work of Divisions 22 and 23 and provide one organized submittal. Upon approval by the CA, the content may be provided in multiple system and equipment-level submittals. Each submission shall be provided at least one month prior to the start of the Acceptance Period. This submittal will be reviewed by A/E, CxA, Owner, and GC within two weeks of the submission. Contractor shall incorporate comments and corrections and resubmit prior to the start of the Acceptance Period.

E. Final Systems Manual Content Submittal: Within two weeks after Functional Completion, Contractors shall provide the final version of all Systems Manual information. Division 22 and 23 Contractor shall provide final version in one single submittal.

F. Maintenance and Updates of Systems Manual Content: Contractors shall maintain the applicable Systems Manual content throughout the Warranty Period. All hard copies will be retained at the Owner's facilities or electronically online at a web-based FTP or Internet site. Changes throughout the Warranty Period shall be fully coordinated with the CxA. Maintenance of Systems Manual content shall include:

1. Changing any indicated settings, parameters, and other operational parameters that were changed by the Contractor during the Warranty Phase.

2. Changing any instructions as to procedures that needed to be changed during the Warranty Phase.
3. Changing the Record Schedules and/or Sequences of Operation if they were changed during the Warranty Phase.
4. Updating any Systems Manual content if changed or updated by the manufacturer.

G. Systems Manual Format and Submission: The Systems Manual contents shall be provided in hard copy and electronic format.

1. Electronic Version: The electronic version of the Systems Manual will be a series of files organized in subdirectories with a summary index with hyperlinks to the various documents and or references to separate CDs that contain the information. During authoring, sample format Microsoft Office documents (Word, Excel or Powerpoint) will be provided to be used by vendors and contractors to provide the custom-authored content to the lead developer for final compilation. Electronic copies of the product data shall be in PDF format. Drawings shall be in AutoCAD or PDF format.
2. Electronic File Submissions. Electronic files of Systems Manual content may be posted to the project website. When a posting is made, emails shall be sent to the receiving Parties (and copied to any other interested Parties) stating that the submission has been posted. Posting should only include the current submission, although the Contractor shall maintain all versions of the submission and provide upon request. When electronic submissions are made on electronic media such as CDs, six copies of the electronic media shall be provided.
3. Paper-Based (Hard) Copies: The number of copies shall be as follows:
    a. Initial construction phase submission shall include 6 copies. All will be returned within two weeks.
    b. Construction Phase submissions shall include 6 copies. All will be returned at the completion of Acceptance Testing.
    c. Final Systems Manual content submission shall include 6 copies. All will remain at the Owner's facilities from that time forward.
    d. Modifications made to the information shall be made to all copies.

1.23 SYSTEMS MANUAL CONTENT AND ORGANIZATION

A. Systems Manual Scope: The Systems Manual format and content requirements shall be as follows. Documents developed or otherwise provided as specified in the Contract Documents should be used directly or referenced to the extent possible, including but not limited to OPR/BOD narratives, shop drawings, submittals, and O&M Manuals. Responsible parties are as indicated in square brackets; tasks not delineated by a responsible party are the responsibility of the lead developer.

B. Part 1 – Facility Information

1. Directory of Entire Manual: Provide a directory indexing the entire set of documents that comprise the Systems Manual.
2. Contact Directory: Include the contact information for all contractors, subcontractors, vendors, manufacturers, and any other entity that has provided goods or services installed at the facility. Contact information should include name, website, address, phone numbers, and technical support phone numbers and email addresses.
3. General Facility and System Description: [A/E] Describe the function of the facility. Detail the overall dimensions of the facility, number of floors, foundations type, expected number of occupants, and facility category code. List and generally describe all the facility systems listed in Part II - Primary Systems Information and any special building features (for example, cranes, elevators, and generators).

4. Floor Plans: [A/E] Provide uncluttered, legible 11 x 17 inch floor plans. Exact copies of the design plans are usually not acceptable because of extraneous information. Include only room numbers, type or function of spaces, and overall facility dimensions on the floor plans. Do not include construction instructions, references, frame numbers, etc.
5. Warranty Information: [GC] Provide all warranties indexed in a logical order.

C. Part 2 - Primary Systems Operating Information: This Part shall be organized by Division then system/subsystem using a systems approach. Part 2 contains system information, whereas Part 3 contains equipment information.

1. System Description [A/E]: Provide a detailed discussion of the system composition and operation. Include technical details that are essential for an understanding of the system. A/E shall provide narratives to the GC who shall provide these to the major subcontractors for use in preparation of their required content. Also cross-reference O&M data contained in Part 4 and product data and submittals contained in Part 4.
2. Contact Information [GC]: Provide contact cross-references to the Parties applicable to the system being described and contained in the main Contact Directory in Part 1.
3. System Flow Diagrams [A/E]: Provide a flow diagram indicating system liquid, air (do not include ductwork) or gas flow during normal operations. Integrate all system components into the diagram. Note that a compilation of non-integrated flow diagrams for the individual system components is not acceptable.
4. Start-Up and Shutdown Procedures [GC]: Provide step-by-step instructions to bring systems from static to operational configurations and from operating to shutdown status. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
5. Normal Operating Instructions [GC]: Provide a discussion of the normal operation and control of the system. Address operating norms (for example, temperatures, pressures and flow rates) expected at each zone or phase of the system. Supplement the discussion with control and wiring diagrams and data. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
6. Emergency Operating Instructions [GC]: Provide emergency operating procedures in the event of equipment malfunctions. Provide shutdown instructions for fires, explosions, spills, or other contingencies. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project. This content shall be in the context of the systems themselves and support the Emergency Operations manual to be created by the Owner.
7. Environmental Considerations [GC]: Provide a listing of the equipment that requires special operation, reporting, testing, analysis or inspection to comply with federal, state or local environmental laws. Examples of possible list items include backflow preventer inspections, underground storage tank testing, hazardous material or waste usage/storage documentation and air pollution control devices. For each item, include requirements for environmental operation, reporting, testing, analysis and inspection as well as references to respective implementing regulations, statutes or policies.
8. Equipment and System Training Documentation [GC]: Include documentation of training for applicable system. Include training agenda, all handouts and presentation materials/content. Reference existence and index of DVD or video tape recording.
9. Sequence of Operation/Control Schematic [A/E]: Provide the written sequence of operation for the applicable system and the control schematic diagram.
10. Maintenance Service Agreements [GC]: Provide copies of maintenance service agreements where there pertain to systems involving multiple components and devices as indexed in Part 3.
11. Test, Adjust and Balancing Reports [GC]: Insert the TAB Reports provided under Section 23 05 93 for the subject system.

D. Part 3 - Maintenance Manual

1. Organize this section first by discipline then by equipment number or ID.
2. Maintenance Index [GC]: Provide a summary table that indexes the equipment requiring maintenance and indicates the frequency each piece of equipment needs attention and a reference to the number of the Procedure associated with that frequency. GC shall provide Contractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the GC for incorporation in the Systems Manual.
3. Maintenance Information [GC]: Maintenance Information for each indexed entry shall contain the following:
    a. Equipment Data Sheet: Provide a summary of key nameplate and performance data.
    b. Procedures: Provide a 'Task Card' or step-by-step procedures for each individual maintenance procedure for a given frequency identified on the Maintenance Index. Include detailed PM procedures, safety instructions and precautions including Lock Out/Tag Out precautions, required skill level, number of personnel needed, frequency, special tools needed, parts needed and estimated time required to complete the task. These procedures shall be indexed in a manner approved by the Owner. These shall be provided as Microsoft Word files or scanned documents from the manufacturer's O&M Manual in either PDF or JPG formats)
    c. Field Test Reports: Provide any Field Test Reports that apply to equipment associated with the system.
    d. Troubleshooting Instructions: Provide detailed troubleshooting instructions indexed by common/expected symptoms. Alternatively, make specific reference to page in the manufacturer's O&M Manual where this information is provided.
    e. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are contained within. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
    f. Special Tools: Provide a listing of any special tools required for servicing, diagnosis, or repair. Alternatively, reference specific page in the manufacturer's O&M Manual where this information is provided.
    g. Supply Inventory Requirements: Provide a list of maintenance and repair supplies (e.g., spare parts, fuels and lubricants) required to ensure continued operation without unreasonable delays. Identify and list parts and supplies that have long purchase lead times. Alternatively, reference specific page in manufacturer's O&M Manual that contains this information.
    h. Sources of Spare Parts: Include reference to contact information where spare parts can be obtained.
    i. Lubrication Schedule: Provide a lubrication schedule indicating types, grades, and capacities of lubricants for specific temperature ranges and applications. Alternatively reference the specific page in the manual that contains this information
    j. Maintenance Service Agreements: Provide copies of maintenance service agreements where they pertain specifically to indexed equipment.
    k. Manufacturer's O&M Manual: Include manufacturer's printed O&M information. These shall be provided in PDF format. If unavailable as PDF from the manufacturer, hardcopy manual shall be scanned and provided as a single file.
    l. Application and Installation Instructions: Where applicable and separate from the O&M information, provide the Application and Installation Instructions that indicate how to correctly apply and install/setup the equipment.

E. Part 4 - Construction Documentation

1. Record Drawings [A/E]: Provide an index of all Record Drawings with drawing number, title, and electronic file name(s) including electronically referenced drawings.
2. Record Specifications [A/E]: Provide a detailed index of the Record Specification. Include sections and major items in the specification all indexed to the appropriate page number.
3. Approved Product Data and Shop Drawings [A/E]
    a. Provide an index of all product data and shop drawings. This shall list all equipment with the associated submittal number
    b. Organize and compile only APPROVED product data and shop drawings. Providing these in a filing format is acceptable provided all files are identified and organized for easy access.
    c. This information is required for this Part in its entirety regardless of inclusion in any other sections of the Systems Manual.
4. Commissioning Record [CxA]: Provide complete Cx records including all Start-Up Documentation and Functional Performance Test documentation.

F. Part 5 – Preventative Maintenance / Recommissioning Manual

1. Preventative Maintenance Specification [CxA]: Specification for day to day maintenance of the facility, including operating log requirement, reports, and preventative maintenance tasks for each system, including recommended inspections, and tests.
2. Recommissioning Test Log [CxA]: Blank testing plan for future use in recommissioning.

1.24 CONNECTION TO OR INTERRUPTION OF EXISTING SERVICES

A. Contractor shall exercise great care in the connection to or interruption of existing functional services (utilities, systems, spaces, etc.) that support the facility. This shall only be done with advance notification, completion of appropriate Owner's documentation to obtain approval, and final approval and supervision by the Owner.

B. Refer to applicable Division 01 sections for logistics and requirements for connection to or interruption of existing services.

C. All events where an existing service will be connected to or interrupted shall be itemized as a milestone or task in the construction Cx schedule. Owner will not approve the connection or interruption unless the event has been forecasted for at least three months. The schedule will not serve as the final notification but will support planning.

D. Final notification shall be per the Owner's process with all forms and submissions complete and accurate. Owner shall provide information on processes and applicable forms on request.

E. Depending on the service, Owner may dictate that the interruption be during non-working hours. In other cases, Owner will require the interruption be during working hours so mission can be monitored.

F. Contractor shall summarize the potential impact and the maximum duration.

G. Owner reserves the right to cancel the connection or interruption at any time if it circumstances necessitate this. The Owner also reserves the right to constrain the extent of any interruption.

H. Connections to Hydronic Systems:

1. Connections to existing hydronic systems shall be done only on mutual written approval of both parties to the connection. Owner and Contractor shall review the fluid and piping condition and any applicable treatment and/or water analyses of the other parties system and agree to the connection.

2. Contractor shall work with the Owner to ensure the balance of the existing hydronic system is not affected to the extent that it will affect mission. Therefore the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least.

3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the Owner.

4. Contractor shall work with the Owner to ensure any applicable pumps do not overload or become dead headed.

I. Connections to Air Systems:

1. Connections to existing air systems shall be done only on mutual written approval of both parties to the connection. Owner and contractor shall review the air quality, inlets and ductwork condition and any applicable filtration of the other party's system and agree to the connection.

2. Contractor shall work with the Owner to ensure the balance of the existing air system is not affected to the extent that it will affect mission. Therefore the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least.

3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the Owner.

4. Contractor shall work with the Owner to ensure any applicable pumps do not overload or become dead headed.

J. Connections to Electrical Systems:

1. Connections to existing electrical systems shall be done only on mutual written approval of both parties to the connection. Owner and Contractor shall review breaker/fuse settings, short circuit studies, the load on the system, and condition of the electrical systems and equipment of the other party's system and agree to the connection.

2. Contractor shall work with the Owner to ensure the loading and coordination of settings are such that the connection will not affect the mission. Therefore the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least. Contractor shall complete and document all interrupter settings and transfer switch timing per the short circuit study and design intent prior to the connection.

3. Contractor shall record the loads on the existing system before and after the connection to document the impact. Interrupter adjustments on the combined system shall commence immediately upon connection unless approved otherwise by the Owner.

4. Contractor shall work with the Owner to ensure any applicable distribution or generation equipment do not overload.

1.25 PHASING PLAN

A. If Contractor intends to start, run, or occupy portions of systems in phases, Contractor shall submit a Phasing Plan for phasing in areas/portions of systems that will be connected subsequent to the initial portions. Phasing Plan shall specifically address:

1. Pipe and Duct Cleaning: Indicate the configurations and protocols for isolating subsequent regions and then protecting the preceding regions when the subsequent region is cleaned/flushed and connected.

2. Pipe Disinfection: Indicate the plan for disinfecting each region of potable water or medical gas pipe that requires disinfection. Indicate how the preceding regions of the system will be protected when connecting subsequent regions.

3. Piping Certification/Testing: Indicate the plan for certifying each region of pipe that requires certification and or testing such as laboratory gases, medical gases, and RO/DI water (testing for water quality). Indicate how the preceding regions of the system will be protected when connecting subsequent regions. Indicate how you will verify that the certification/test results on the previous systems have not been invalidated.

4. System Modifications: Indicate the protocols for making subsequent changes to the systems of pipe and duct when the systems have already been cleaned, flushed, pressure tested, disinfected, and certified.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used in the Cx process shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard testing instrumentation normally used for performance assessment and diagnosis will be provided by the CxA. Refer to Sections 23 08 00 and 26 08 00 for a list of applicable test equipment.

C. Special Tools: Special equipment, tools and instruments (only available from a vendor, and specific to a piece of equipment) that are required for testing equipment in accordance with these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon completion of the project.

2.2 WEB-BASED COMMISSIONING PORTAL

A. General: The Cx Portal ('Portal') is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process. The Portal uses a hierarchical object tree to represent building systems, components and devices. From this object tree, one can access associated information at and below the applicable level. All applicable elements of information are associated with the object tree. The Portal facilitates either completing information directly via the software or by printing forms to fill out in the field.

B. Participation: All general and major subcontractors participating in the Cx process shall participate in the use of the Portal to document the Cx procedures.

C. Requirements for Use: Options for accessing and interfacing with the Cx Portal are as follows:

1. Print, Test, and File: Using this approach, Contractors simply go online to the Portal using a web browser, print checklists and tests as needed, fill them out in the field, and enter the results back into the Portal database when completed.

2. Online in the Field: The applicable documents can be accessed and filled out live and online if the Contractor has the means to access the Internet while working in the field using a local Wi-Fi network or wireless air card.

3. Database Client: At the Contractor's option, the CxA can provide the Contractor with a software tool that will allow the Contractor to download electronic test database files from the Portal, work on the database files in the field electronically (but offline), and later synchronize their entries with the master database on the Portal.

D. Portal Training: Included in the contract are two Contractors training sessions given by the CxA (one scheduled near the Construction Phase Cx Kickoff Meeting and one scheduled prior to the first equipment Start-Up). Contractors shall send at least one representative to at least one training session. Each Contractor is entitled to two hours phone technical support beyond training sessions.

PART 3 - EXECUTION

3.1 START-UP STANDARD OF CARE

A. Procedures that establish a minimum Standard-of-Care for the start-up, checkout and testing of applicable equipment are specified in the individual technical specifications and in Section 01 91 00 and Sections 23 08 00 and 26 08 00. Contractor shall apply this Standard-of-Care and document per the Cx requirements.

3.2 FUNCTIONAL PERFORMANCE TEST EXECUTION

A. Functional Performance Testing procedures are specified in Section 01 91 10. Contractor shall participate in the development and approval of the testing procedures, as well as participate as required in the initial sample of tests as indicated herein.

3.3 ACTION LIST

A. CxA shall maintain an Action List tracking Action Items (required information, identified deficiencies, work required, etc.) that relate to the Cx process. Each item shall be tracked with the initiator, the Parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.

B. CxA will disseminate this list as appropriate to keep all Parties informed.

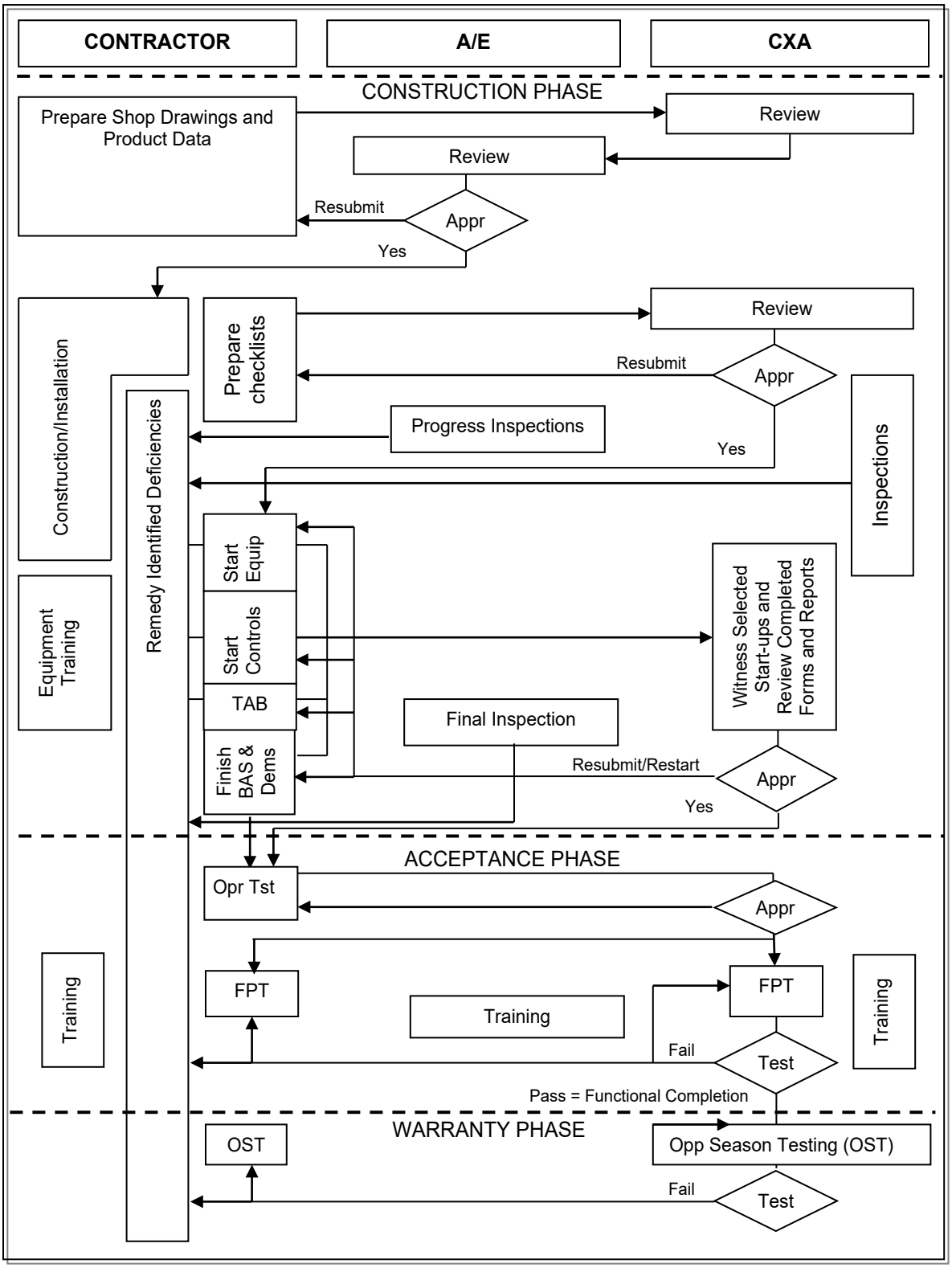
C. All Parties indicated as responsible for an Action Item shall respond. Parties participating using the Portal shall respond via the Portal. Other Parties may respond by separate email.

D. The originator of an Action Item shall close it and record the resolution. Closing an Action Item amounts to entering the date on which it was addressed.

3.4 SEQUENCING ILLUSTRATION

A. A simplified schematic diagram of the precedents involved in the Cx process is provided below. The diagram is generally applicable on a system-by-system basis. Different systems or areas of the building may be phased or sequenced such that different systems are at different points in the Cx process. The diagram indicates tasks for the Contractor, the A/E and the CxA. Tasks for each are indicated vertically below their name. The individual tasks are as defined herein. Management protocols are also covered herein.

<This area intentionally left blank. See following page for Commissioning Workflow diagram>



Sequencing Illustration

END OF SECTION

SECTION 01 91 10

FUNCTIONAL PERFORMANCE TESTING (FPT) PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: The Work of this Section shall include but not be limited to the following:

1. Functional Performance Testing (FPT; 'testing') of systems.
2. Documentation of FPTs.
3. Acceptance criteria.

B. Related Sections

1. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.
2. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.3 SCOPE

A. This section describes the Functional Performance Testing (FPT) process, procedures, and requirements. It is intended to illustrate (i) the Contractor's requirements for assisting the Commissioning Authority (CxA) with the Functional Performance Testing of systems, and (ii) to demonstrate the level at which systems and equipment will be tested prior to being deemed 'Acceptable' to the Owner.

B. The CxA will prepare itemized and detailed FPT plans and procedures that:

1. Specify individual tests and procedures that meet the general requirements of the Cx Plan and commissioning (Cx) process;
2. Serve to document and record the testing procedures and the results of the tests.

C. The Contractor shall provide technical input to the CxA as needed during the development of the final project FPTs.

D. Example (referred herein to as 'generic') FPTs are provided as illustration to the Contractor of the level of detail to which FPTs will be conducted.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations. This paragraph includes a comprehensive list of acronyms describing the various required Parties referred to in the Section for individual FPTs.

1.5 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.6 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope: Systems shall be tested to ensure proper operation through all modes of operation including normal expected operation, maintenance operation as well as proper response to system and component failures that are considered abnormal operation as indicated below.

1. Normal Operation: Each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. These series of tests will demonstrate that the systems and equipment operate throughout typical operation including normal adjusting, cleaning, media replacement, and maintenance.

2. Abnormal Operation: Test each system to simulate possible abnormal conditions and verify proper responses to such modes and conditions as power failure, equipment and component failure, freeze condition, deviation of operating parameters outside of normal, no flow, supporting utility failure, human error, etc. Abnormal operation tests shall demonstrate proper and safe response to the subject systems and the other systems that it affects or integrates with. These tests shall also demonstrate proper enunciation of abnormal conditions to quickly and effectively notify users and operators of such condition. Specific modes required in this project are given in this section and any other sections where test requirements are found.

B. Development of Test Procedures: CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection, and scope. The CxA will also submit the tests to the A/E for review.

1. Contractor shall review the FPTs in detail and approve them.

2. The CxA shall review Owner-contracted testing, factory testing, or required Owner acceptance tests for which the CxA is not responsible to oversee. Review shall include content, scope, and documentation format, and shall determine what further testing or format changes may be required. Redundancy of testing shall be minimized.

3. The purpose of any given specific FPT is to verify and document compliance with the stated criteria of acceptance.

C. Scheduling: GC shall schedule the Functional Performance Testing after system ‘Turn-Over’ occurs (Turn-Over is the official Contractor notification that systems have completed Start-Up and are ready for testing and submittal and review of all the required submittals has occurred). To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.

D. Phasing: Non-interdependent segments of the project testing can be phased. Phasing of this project is described below

E. Participation: CxA will direct and conduct Functional Performance Tests after Start-Up Documentation of systems and equipment has been reviewed and accepted and system ‘Turn-Over’ occurs. The testing involves all parties including the Contractors, but is directed by the CA. As such, the following paragraphs define the level of Contractor involvement required for FPT support. This time allotment for FPT support does not include the time for ATC system Demonstration, repairs of any deficiencies, retesting as a result of failed testing, or any of the pre-functional start-up tests required within the specifications. This does not include the requirements for Off-Season testing.

1. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible. The CA will notify each trade of the testing which they must participate. Only those notified Contractors, which participate in the testing, will be credited for the hours against their FPT allotment.

2. No party involved with the project is prohibited from participation in or witnessing of any tests. Any contractor may elect to witness all tests on their systems even if their involvement is not directly requested by the CA. In these instances the time used by the Contractor is not part of the FPT allotted hours.
3. The maximum required time for contractor FPT participation (in hours) is indicated below, by trade. Each category of support is to be provided by the contractor responsible for the installation of the system (e.g., the fire alarm support is to be provided by the FAC). Additional time required by the Contractor due to incompleteness of the system, failure of tests, or failure of sampling criteria shall be at the contractors expense, with no additional costs to the Owner.
    a. Mechanical (HVAC) FPT Support – 16 hours.
    b. Mechanical (Plumbing) FPT Support – 8 hours.
    c. Building Automation System FPT Support – 60 hours
    d. Electrical FPT Support –24 hours
    e. Fire Alarm FPT Support – 16 hours.
    f. TAB FPT Support – 16 hours
4. The CA will track the Contractor's FPT participation based on 4-hour segments of work, except as noted below.

F. Detailed FPT Development and Contractor Review: CxA will prepare detailed and itemized testing procedures to define and document the FPT. These will be typically be developed during the Construction Phase and completed during the Acceptance Phase. The CxA shall submit these procedures to the Contractor for review. Contractor shall indicate all required limitations, safety procedures, maximum thresholds, and any other parameters during the FPT development. Contract shall be responsible for any damage to the equipment caused by Functional Performance Testing done per the procedures and within the limitations of the approved procedures.

G. Completeness: All systems must be completed and ready for FPT. All Start-Up Documentation, factory-authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and started for the respective system or component.

H. Test Documentation: CxA will conduct tests, and/or witness tests as applicable. CxA will record all test results on the forms developed for the testing. CxA will 'Pass' or 'Fail' the testing and record the date and time of the test. Deficiencies shall clearly be indicated when the test is failed. When all related testing is completed successfully, CxA shall recommend acceptance of the system or component.

I. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. More significant deficiencies will require failure of the test and re-testing. Deficiencies of this magnitude will result in an Action Item on the Action List. The resolution of the deficiency will then subsequently be tracked by the CxA via the Action List. All tests shall be repeated until successful completion. Refer to more specific provisions below.

J. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated in the generic FPT provided elsewhere in this Section.

K. Max Failure Limit and Sample Percentages: A 'Maximum Failure Limit' is indicated along with the 'Sampling Percentages'. The Max Failure Limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. This is based on the concept that if many failures occur, it is a result of inadequate start-up by the Contractor. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

1. If no Max Failure Limit is indicated, all tested samples must pass (Max Failure Limit = 0%).

2. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems), the Maximum Failure Limit will apply per system.

3. The responsible Contractors shall pay the CxA cost of that sample test, and redo the start-up/TAB for the applicable devices/systems.

4. All work necessitated by sample failures shall be at no cost to the Owner.

L. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Opposite Season testing will be required where scheduling prohibits thorough testing in all modes of operation. Air handler and central heating system testing for heating-related modes of operation and control loops shall be tested during outside air temperatures below 25°F.

M. Approval. The CxA passes each test and subsequently recommends approval to Owner who reviews and approves the FPT.

1.7 COORDINATION BETWEEN TESTING PARTIES

A. Factory Start-Ups: For many systems and equipment, Factory Start-Ups are specified. These Factory Start-Ups will be reviewed and checked during Functional Performance Testing. All costs associated with the Factory Start-Ups are included with the bid unless otherwise noted. Contractor shall make notification of when Factory Start-Ups are occurring and coordinate these with witnessing Parties. The CxA and other Cx Team members may witness Factory Start-Ups at their discretion. Aspects of Functional Performance Testing accomplished during the Factory Start-Ups may be accomplished and approved by the CxA if they meet the intent of the FPT.

B. Independent Testing Agencies: For systems where Independent Testing Agencies are specified, the cost of this testing shall be included with the bid unless otherwise noted. Much of the testing performed by Independent Testing Agencies will cover aspects required in the Start-Up Documentation and Functional Performance Tests.

1. Contractor and testing agencies shall coordinate with the CxA so that the CxA can witness the testing and approve the applicable aspects of the FPTs.

2. The CxA may in some cases independently spot-check work of the testing agencies if the tests were not witnessed. However, it is not the intent for the CxA to re-accomplish testing by others that is specified in the construction specifications. For instance, much of the testing requirements for the electrical systems will be performed by the independent electrical testing agency provided under the bid. The CxA shall witness the indicated sample of the testing and record the results in the record of Functional Performance Tests.

3. Contractor is responsible for coordinating the efforts of testing agency with that of the Cx process. Documentation shall be contiguous and seamless and duplication should be avoided. Testing agencies shall complete the documentation of the Cx process as required.

C. Specialized Testing by Contractor: Where Specialized Testing is specified in the technical specifications, the Contractor, subcontractor, vendor, or factory representative as applicable shall conduct the Specialized Testing and provide all specialized instrumentation and equipment. CxA and other Cx Team members may witness tests at their discretion. The CxA may in some cases independently spot-check the results of the tests if the tests were not witnessed. However, it is not the intent for the CxA to re-accomplish testing that is specified in the construction specifications. All Specialized Testing procedures shall be integrated with the Cx process and all documentation shall be coordinated and integrated with the documentation of the Cx process. Examples of Specialized Testing include but are not limited to:

1. Generator load testing (not including building power outage testing which will be administered by CxA)

2. Acceptance testing of the fire alarm system

3. Fire suppression system hydraulic tests
4. Electrical system testing per NETA
5. Uninterruptible Power Supply

1.8 FPT ACCEPTANCE CRITERIA

A. The Acceptance Criteria shall be as follows unless more specifically indicated within individual tests. CxA may exercise professional judgment to relax requirements and pass tests and recommend approval when appropriate.

1. Capacity: Capacity and/or equipment performance will generally be as specified ±5%.
2. Efficiency: Efficiency where specifically indicated in the documents will be ±5%. When inferred from manufacturer's catalogue data, criteria will be ±10%.
3. Balancing: Balancing-related criteria will be ±5% for water and ±10% for air.
4. Accuracy: Accuracy/repeatability on sensing devices will be as specified for the device. CxA and TAB will use calibrated gages for independent validation and use judgment in passing or failing the devices. In many cases, the coordination of multiple related sensors is more important than absolute accuracy.
5. Controls: Control feedback loop response and setpoint deviation criteria will be as specified in Section 23 08 01.
6. Sequences: HVAC sequence-related criteria will be as explicitly specified in the documents and as interpreted by the CxA. Code required sequencing shall be per the applicable code.
7. System sequences shall be as required by the approved shop drawings.
8. Motor Phase Imbalance: Shall be no more than 2% (Amps and Volts).
9. Noise Levels:
    a. Occupied Spaces: As indicated in the Owner's Project Requirements or Basis of Design (OPR/BOD) document. Otherwise, noise level shall be as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.
    b. Max 77dBa at 3' from a UPS.
    c. Max 65dBa at 7' from an Engine Generator Set.
    d. At limits of the enterprise or facility: As required by current local ordinances.
10. Indoor Environmental Parameters (T, RH, CO_2, VOC): Shall be as indicated in the Basis of Design document. Otherwise, as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.
11. Air Pressurization: As indicated in the OPR/BOD document. Otherwise, as indicated in the most current version of the ASHRAE Handbooks for the applicable occupancy. Smoke/shaft pressurization shall be as required by NFPA to maintain maximum door opening forces and to restrict the passage of smoke.
12. Indoor Lighting Levels: As indicated in the OPR/BOD document. Otherwise, as recommended in the most current version of the IES Handbooks for the applicable occupancy.
13. Electrical Systems: Shall be in accordance with manufacturer's recommendations of individual components and devices, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-Latest Version.
14. Inter-system interfaces and coordination: As specified and generally to ensure safe, reliable, and robust operation.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available. Supplier of instrumentation shall submit the calibration certificates along with the startup documentation.

B. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis will be provided by the CxA for tests being conducted by CxA. All other instrumentation shall be provided by the Contractor. The instrumentation to be provided by the CxA includes:

1. Electronic manometer (for air and flow hood)
2. Electronic manometer (for water)
3. Temperature instruments and gauges
4. Humidity instruments and gauges
5. CO_2 instrument
6. Sound meter
7. Light level meter
8. Electronic multimeter
9. Power analyzer (including power factor and THD)
10. Receptacle tester
11. Tachometer
12. Belt tensioner
13. Ultrasonic flow meter
14. Vibration meter capable of measuring peak-to-peak acceleration

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and provided to the Owner.

1. Provide a temporary license to software needed to access the BAS at both the terminal equipment and on the primary LAN/at primary controllers. Provide all configuration utilities needed to read all parameters and set up terminal boxes. Provide temporary graphic interface software license for use during the Acceptance Phase.

PART 3 - FUNCTIONAL PERFORMANCE TESTS (SYSTEMS AND EQUIPMENT RELATED)

3.1 PREREQUISITES

A. All equipment, components, and devices applicable to the FPT must be started and operational and systems must be 'Turned-Over' to the Cx Team. This includes completion and of Start-Up Documentation, pressure testing of equipment, duct, piping; flushing/cleaning of applicable systems; completed labeling and identification; completed insulation of applicable systems; and all other requirements for placing system into dynamic operation.

B. Unless specifically agreed to by the Owner and CxA, all support systems shall be complete prior to FPT. For instance, an air handler will require that:

1. The electrical system serving it is completed and tested;
2. The hydronic systems serving it have been pressure tested, flushed, and functional performance tested;
3. Balancing has been accomplished on the air and water sides;
4. The control systems have been started and calibrated.

C. The CxA shall determine the optimal sequence of testing.

3.2 FUNCTIONAL TESTING PROCESS

A. Functional Performance Testing ('Functional Testing') on any given system shall typically begin with testing device-level elements such as sensors and actuators; progress to component-level assemblies of devices; then to system-level, then to inter-system level, then to building-level.

B. Functional Testing of systems shall generally proceed from the utilities to the central systems, to the distribution systems, to the zone terminal units and services. CxA shall plan this process and communicate it through a precedent schedule (in Excel format). Construction Manager shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

3.3 FUNCTIONAL TESTING STRATEGY

A. The CA will test those equipment and systems generally specified in Divisions 11, 13, 21 22, 23, 26 and 28. The specific equipment and systems are detailed in their respective Cx sections for those Divisions.

B. The testing of the systems will be performed in a structured sequence which tests the central plant or utility first, followed by the distribution system and the terminal equipment. The details for the phasing of the FPTs are to be determined by the CxA and integrated into the start-up, pre-Cx, and demonstration schedules for the Contractors by the GC.

C. Following the completion of the "system" FPTs, integrated testing such as power blackout tests, fire alarm/ATC interface, etc. will be tested.

3.4 COMMON ELEMENTS FOR ALL SYSTEMS

A. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.

B. Contractor shall provide the completed Start-Up Documentation and shall follow Turn-Over procedures as specified in Section 01 91 00. CxA shall review the Start-Up Documentation and spot-check the installation prior to or at the beginning of the FPT.

C. Contractor shall demonstrate that access is sufficient to perform required maintenance.

D. BAS trends shall have been established as required in the documents. These shall be available for review prior to or during the FPT.

E. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources.

F. Capacities and adjusted/balanced conditions as applicable shall be subject to check.

G. Sequencing Verification: All modes of operation and actions shall be verified for equipment/system samples.

H. System and equipment configurations shall be compared against the contract documents.

I. Verify functions (such as heating and cooling) are coordinated and do not overlap or 'fight'.

J. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation.

K. BAS or Local Panel Dynamic Graphics: The graphic displays for all components, systems, and areas required to be represented by a BAS graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints or other parameters are required to be adjustable, CxA shall verify that they can be adjusted directly from the graphic screen.

L. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Mechanical contractor shall be available for the power outage test to test mechanical systems under a power outage. This is in addition to the requirements specified for the mechanical system.

M. Where system and zones are designed for various modes of operations, test representative systems in all modes of operation. This includes:

1. Seasonal Modes
2. Sequencing Modes
3. Emergency Modes

PART 4 - INTERACTIVE SYSTEM FUNCTIONAL PERFORMANCE TESTS

4.1 PREREQUISITES

A. Testing for all systems, equipment, components, and devices applicable to the Integrated System Functional Performance Tests (ISFPT) must have successfully passed system-level Functional Testing and all FPTs must be documented.

B. Minor punchlist items may be outstanding provided they do not affect functionality and provided that all punchlist items, or incomplete work have been documented by the Contractor at the time they notify the CxA that they are ready for ISFPT. If a punchlist item causes the failure of any aspect of the ISFPT, that Contractor will be responsible for the cost of retesting.

C. All device, component, equipment, and systems training shall be completed. Exceptions to this include BAS Final Sequence Training, Commissioned System Training, and occupant training on use of specialized equipment, and as otherwise approved by Owner and CxA.

D. The CxA shall work with the GC to determine the optimal sequence of testing. ISFPTs shall be itemized and specifically indicated in the construction schedule.

E. Owner furnished FF&E may be used in ISFPTs in some cases. Coordinate with the Owner to obtain and connect this equipment. Examples include:

1. Fume Hoods
2. Spot hoods and snorkel exhausts
3. Portable generators when needed to test temporary power connections
4. Coordinate with the Owner's intended source for temporary boilers. Contractor shall pay for any addition rental necessitated by their failure.
5. Compressed gas supplies to support functional performance testing of associated systems

4.2 ISFPT PROCESS

A. ISFPT will generally be done at the inter-system level up to building-level as applicable.

B. ISFPT will generally require extensive coordination to avoid simulating various interactions and affects multiple times for each system. ISFPTs shall only be done with 14 days prior notification. The ISFPT will typically begin with a meeting to coordinate responsibilities and sequence.

C. CxA shall work with the GC to plan the overall ISFPT progression and communicate it through a precedent diagram (in Gantt or Pert format). GC shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

D. ISFPTs will affect or be an element of many individual system and equipment FPTs. Results of these tests will be recorded in the context of the individual system tests although the testing will generally be done on many of the systems at the same time. CxA shall record the overall results of the ISFPT, however the details will be recorded in the context of the applicable systems, equipment, or zones.

E. Communications are critical during ISFPTs. GC shall provide radios with sufficient range to cover the building and or place personnel to relay communications when necessary.

F. Participation: Unless noted otherwise, ISFPTs will require participation of all indicated Parties for the entire test. Any Cx team member is allowed to attend unless security requirements pertain. ISFPTs will not be done on a sampling basis. While sampling of individual systems might be part of the ISFPT, the ISFPT itself will not be considered a sample.

G. Remediation of Deficiencies: Minor deficiencies may be remedied during the FPT only with the consent of the CxA who will poll all Parties involved. Given the extent of coordination required with the ISFPT, reasonable efforts will be made to fully complete and pass the test on the scheduled date.

H. Failures: The Parties responsible for failures of ISFPTs will be responsible for the cost of any necessary retesting as provided for under Section 01 91 00.

I. Monitoring and Trending: For almost all of the ISFPTs, monitoring of various systems must be in place and trends shall be set up to archive conditions throughout the test. In many cases, analysis of the trends will be the basis of assessing success. As the ISFPTs will be performed towards the end of the Acceptance Phase, contractor shall ensure all trending shall be in place as required by the applicable system Functional Performance Tests throughout the entire Acceptance Phase and Endurance Period (if applicable).

J. Some of the ISFPTs may be allowed during the Endurance Period upon the approval of the Owner and CxA (if applicable).

4.3 BUILDING POWER OUTAGE TEST

A. Purpose: To confirm safe and effective response of building systems to the loss of the electric power utility serving the systems. Also to confirm proper operation of emergency backup systems and proper operation of systems being served by emergency power.

B. Participants shall include: CxA, BAC, MC, EC, FAC, FSC, GC, SSC, Owner's Operating Personnel (specifically the electrical, plumbing, and HVAC shops shall be represented), Elevator Contractor. Generally EC shall provide personnel to staff the main electrical rooms. BAC shall provide personnel to monitor the Operator Interface and main mechanical rooms. MC shall provide personnel to staff the main mechanical rooms. FAC shall provide personnel to staff the Fire Command Center. FSC shall provide personnel to staff the fire service and pump room. Elevator Contractor shall provide personnel to staff the elevator. SSC shall provide personnel to staff the main security room.

C. Prerequisites: Aspects of other Functional Performance Tests will be done in concert with this test. Coordinate this test only after all systems are ready for power outage tests.

1. Assess expected results and response of the outage on all systems. Ensure that there is a plan to safely respond to a power outage before conducting the test.
2. Access cards shall be issued as required to test the security system. Refer to Security System FPT.
3. Fuel shall be provided by the Contractor to run the Emergency Generator for at least 6 hours.
4. GC shall provide or consolidate enough radios to allow at least one member of each team to communicate throughout test.
5. Provide adequate flash lights to all team members for safety.
6. Owner shall provide any portable backup generators required for the test.

D. Coordination: Start test with a meeting to coordinate responsibilities. During test phases, confirm all teams are ready for the next phase before proceeding to the next phase. End with a meeting to discuss results and need for further testing.

E. Monitoring: In addition to all monitoring and trending required for all the system FPTs, EC shall provide data loggers to trend the power to any panel downstream of each ATS. Sampling shall be set up at 0.5 second intervals or less.

F. Simulate all potential combinations of power outages reasonably possible.

1. Simulate prolonged outage, at least 2 hours by opening main feeders.
2. Simulate momentary total outages by opening and closing main breakers as quickly as possible.
3. Simulate individual feeder outages when multiple feeders are provided. All feeders shall be interrupted.
4. On critical facilities, where connections are provided for portable electrical back up, fail the emergency generator during the outage and connect the portable generator.

G. While normal power is disconnected, survey the facility for safe conditions and system operation as applicable.

H. Return to normal power.

I. Validate the proper system interaction and response of the individual systems per Part III.

4.4 CONTROL LAN COMMUNICATION FAILURE

A. Purpose: To ensure stand-alone functionality of the BAS controllers. Also to ensure alternate means of emergency notification where occupancies are dependent upon it.

B. Participants shall include: CxA, MC, BAC, GC, Owner's Operating Personnel (specifically the plumbing and HVAC shops shall be represented), safety authorities if BAS is responsible for emergency condition notification. MC shall provide personnel to monitor all major equipment that uses control compressed air. BAC shall provide personnel to staff the operator interface and each major mechanical room.

C. Prerequisites: Aspects of other Functional Performance Tests will be done in concert with this test. Coordinate this test only after all systems are ready for steam outage tests.

1. Assess expected results and response of the outage on all systems. Ensure that there is a plan to safely respond to a controller LAN before conducting the test.

D. Coordination: Start test with a meeting to coordinate responsibilities. During test phases, confirm all teams are ready for the next phase before proceeding to the next phase. End with a meeting to discuss results and need for further testing.

E. Defeat the communications on the BAS LAN by compromising the routing table. Ensure the stand alone functionality of the controllers. Confirm the enunciation of the failure. Observe system sequences.

F. Validate the proper system interaction and response of the individual systems per Part III of this section.

4.5 FIRE ALARM SIMULATION

A. Purpose: To confirm safe and effective response of building systems to a fire in the building. Also to confirm proper response of safety personnel to the fire.

B. Participants shall include: CxA, EC, BAC, GC, Owner's Operating Personnel, FAC, MC, SSC, and Safety Authorities. MC shall provide personnel as required to staff each main mechanical room that includes systems that will react to the fire alarm as well as three other individuals to contribute to teams. FAC/EC shall provide personnel to staff the Fire Command Center plus 3 other individuals to contribute to the teams. SSC shall provide personnel to staff the security room and three individuals to contribute to the teams.

C. Prerequisites: Aspects of other Functional Performance Tests may be done in concert with this test. Coordinate this test only after all systems are ready for the fire alarm simulation.

1. Coordinate test with the Fire Department

D. Sample: One typical space in each major occupancy classification and/or zone including (safety response will only be once):

1. 100% of high security or high containment enunciation and egress.

E. Coordination: Start test with a meeting to coordinate responsibilities. During test phases, confirm all teams are ready for the next phase before proceeding to the next phase. End with a meeting to discuss results and need for further testing.

F. Initiate a smoke detector or pull a fire alarm pull station in an occupied area of each major occupancy classification. Where elevators are used, initiate a smoke detector in the primary elevator recall floor lobby to ensure alternate floor recall.

G. Validate the proper system interaction and response of the individual systems per Part III of this section for the following:

1. Fire Alarm System
2. Smoke Evacuation System
3. HVAC System
4. Coordinate with Elevator contractor and approval authorities to validate elevator response.
5. Security System

H. Check egress paths during test to validate both proper evacuation egress and proper access control as indicated for security system.

I. Coordinate and observe actual response from fire department.

1. Fire fighters shall use Smoke Control Panel to override systems. (This is primarily for the fire fighters benefit as the functionality of every system will have been validated during the system tests.)

END OF SECTION

DIVISION 03
CONCRETE

SECTION 033000 - CAST IN PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

A. Section includes but is not limited to the *following* as shown on the drawings and as specified herein:

1. Foundation systems including footings, caissons, caisson caps, piles, walls, beams, piers, pilasters, pits and similar concrete.
2. Slabs on grade.
3. Structural slabs on grade.
4. Structural slabs on metal deck.
5. Cast-in-place slabs, beams, walls, and columns.
6. Topping slabs
7. Stair pan fills.
8. Furnishing and installing all required anchors and inserts.
9. Placing in the forms all inserts, anchors, anchor bolts, bearing plates and the like furnished by other trades for casting into the concrete and cleaning of same after stripping of forms.
10. Protection of all inserts, anchors, hangers, sleeves and supports furnished and set by others for the attachment of other work to the concrete, or required to permit the passage of other work through the concrete.
11. Supply, fabricate and place all required reinforcing bars, mesh and other reinforcement for concrete where shown, called for, and/or required complete with proper supporting devices.
12. Erection and removal of all formwork required to properly complete the work.
13. Finishing of all concrete work as hereinafter specified.
14. Curing and protection of all concrete work.
15. Site concrete consisting of curbs, walls, pads, boxes and the like as shown on the drawings.
16. Floor sealers and dust-proofing of all areas exposed and/or covered with carpet.
17. Cutting, patching, grouting, repairing and pointing up as required.
18. Vapor barrier system below slabs on grade.
19. Under slab drainage course.
20. Dewatering.
21. Waterproofing.
22. Grouting of all beam bearing plates and column base plates.
23. Embedded plates in all foundation walls.
24. Equipment pads as required.
25. All other work and materials as may be reasonably inferred and needed to make the work of this section complete.
26. Waste Management

B. Related Requirements:

1. Division 01 Section “Construction Waste Management and Disposal”

2. Division 04 Section “Unit Masonry”
3. Division 05 Section “Structural Steel”
4. Division 05 Section “Metal Deck”
5. Division 05 Section “Metal Fabrications”
6. Division 06 Section “Rough Carpentry”
7. Division 07 Section “Waterproofing”
8. Division 07 Section “Joint Sealants”
9. Division 07 Section “Expansion Joint Cover Assemblies”
10. Division 31 Section “Dewatering”

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. The Contractor is to implement practices and procedures to meet the Project’s Sustainable Design goals. The Contractor shall ensure that the requirements related to these goals, as defined in this Section and in Related Sections of the Contract Documents, are implemented. Substitutions, or other changes to the Work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project’s Sustainable Design goals.

B. The Contractor is to efficiently use resources and energy while executing the Work of this Section. Resource efficient aspects to be considered in completing this Project include the use of techniques that minimize waste generation, reuse of construction materials on site where possible, and recycling of waste generated during the construction process.

C. Performance Requirements: The following criteria are required for the products included in this section

1. Preference shall be given to cast-in-place concrete containing raw materials harvested or extracted within 500 miles of the project site.
2. Adhesives, sealants, paints and coatings used for the work of this section shall meet the Volatile Organic Compound (VOC) limits where applicable.

1.4 SUBMITTALS

A. Product Data: Submit data for proprietary materials and items, including the following:

1. Reinforcement
2. Supports for reinforcement
3. Forming accessories
4. Admixtures
5. Patching compounds
6. Waterstops
7. Joint systems
8. Curing compounds
9. Dry-shake finish materials
10. Others items as requested by Architect.

B. Shop Drawings; Reinforcement: Submit original shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Details and Detailing of Concrete Reinforcement" showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. The shop drawings shall be prepared only by competent detailers, checked by the contractor prior to submission.

1. The shop drawings shall show construction, contraction and isolation joint locations and the added reinforcement required at same.
2. Obtain and coordinate information for sleeves and openings in concrete, which are required for the work of other trades. Make coordinated drawings showing size and location of openings and sleeves and incorporate this information on the reinforcing drawings.
3. Only those splices indicated on the approved shop drawings will be permitted.
4. Provide elevations of all foundation walls and other structural elements to a minimum 1/4" scale.

C. Shop Drawings Formwork: Submit shop drawings for fabrication and erection of specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually. Architect's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility, prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

E. Contraction Joint Layout: Indicate proposed contraction joints required per applicable codes and drawings.

1. Location of contraction joints is subject to approval of the Architect.

F. The use of the Architect's or Engineer of Record's electronic drawing files as a base for the reinforcement, formwork, and joint layout shop drawings will be permitted at the request of the detailer/designer upon completion and return of the waiver form. The use of the Architect's or Engineer of Record's electronic drawing files as a base for shop drawing details will not be permitted. The detailer/designer will be responsible for compatibility of the files with his hardware or software. The electronic files are not to be considered the contract documents, the design team makes no representation regarding the accuracy or completeness of the electronic files given to detailer/designer and their use will be at the detailer/designer's sole risk and without liability to the design team. The detailer/designer shall remove the project title box and all references to the structural drawings including drawing numbers and structural drawing sections and details. The detailer/designer shall also remove all reference to work not included in the concrete contract.

G. Scaling of the Architect's or Engineer of Record's drawings is not permitted. This applies to hard paper, electronic, and all other versions.

H. Laboratory Test Reports: Submit laboratory test reports for concrete materials, mix design test and microwave test.

I. Material Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Architect. Manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements shall sign material certificates. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

J. Cold Weather and Hot Weather Concreting Procedures: Submit written descriptions of contractor's proposed cold weather and hot weather concreting procedures, when applicable.

K. Certification that pozzolanic materials conforms to ASTM C 618-01 (noting class C or class F), ASTM C 989 or ASTM C1240.

L. Formwork: Specify whether reusable, permanent, salvaged or new wood forms are to be used.

M. Recycled Aggregate: Provide laboratory reports indicating that aggregate conforms to ASTM C33 for structural concrete or ASTM D1241-00 for sub-base material. Provide cut sheets clearly indicating the source, total weight and volume of the recycled aggregate. If aggregate provided is a mix of virgin and recycled aggregates obtain a written affidavit from the manufacturer stating the recycled content percentage

N. VOC content for curing compounds, sealants and release agents: Provide a cut sheet and a Material Safety Data Sheet (MSDS) for each curing compound, sealant, hardener and release agent used highlighting VOC contents. VOC content must be less than or equal to limits stated under “PRODUCTS”.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

C. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. New York State Building Code, Latest Edition
2. ACI 117 “Standard Specifications for Tolerances for Concrete Construction and Materials and Commentary.”
3. ACI 211.1 “Standard Practice for Selecting Proportions for Normal, Heavyweight and mass concrete.”
4. ACI 211.2, “Standard Practice for Selecting Proportions for Structural Lightweight Concrete.”
5. ACI 214R, “Evaluation of Strength Test Results of Concrete.”
6. ACI 232.2R, “Use of Fly Ash in Concrete.”
7. ACI 233R, “Guide to Use of Slag Cement in Concrete and Mortar.”
8. ACI 234, “Guide for the Use of Silica Fume in Concrete.”
9. ACI 301 “Specifications for Structural Concrete.”
10. ACI 302.1R “Guide for Concrete Floor and Slab Construction.”
11. ACI 304R, “Guide for Measuring, Mixing, Transporting and Placing Concrete.”
12. ACI 305R “Hot Weather Concreting.”
13. ACI 306R-10 “Guide to Cold Weather Concreting.”
14. ACI 308.1 “Standard Specification for Curing Concrete.”
15. ACI 309R, “Guide for Consolidation of Concrete.”
16. ACI 311.4R, “Guide for Concrete Inspections.”
17. ACI 315, “Details and Detailing of Concrete Reinforcement.”
18. ACI 318 “Building Code Requirements for Structural Concrete and Commentary.”
19. ACI 347 “Guide to Formwork of Concrete.”
20. Concrete Reinforcing Steel Institute, (CRSI) “Manual of Standard Practice.”
21. CRSI-WCRSI, “Placing Reinforcing Bars.”
22. AWS D1.4, “Structural Welding Code Reinforcing Steel.”
23. The ACI Field Reference Manual, SP-15 shall be kept at the job site, and the practices set forth therein shall be strictly adhered to.
24. ASTM Standards as applicable in the building code of the local jurisdiction and as noted in this specification.
25. AASHTO T 318, “Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.”

D. Concrete Testing Service: Owner will engage a testing laboratory acceptable to Architect and Engineer of Record to perform material evaluation tests and to design concrete mixes.

E. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

F. Preconstruction Meeting:

1. At least 25 days prior to the start of the concrete construction schedule, the Contractor shall conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction. The Contractor shall send a pre-concrete conference agenda to all attendees 5 days prior to the scheduled date of the conference.
2. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

    a. Contractor's superintendent
    b. Laboratory responsible for the concrete design mix
    c. Laboratory responsible for field quality control
    d. Concrete subcontractor
    e. Ready-mix concrete producer
    f. Admixture manufacturer(s)
    g. Concrete pumping equipment manufacturer.

3. Minutes of the meeting shall be recorded, typed and printed by the contractor and distributed by the contractor to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes: Owner or owner's representative, Architect, and Engineer of Record.
4. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design and placing can produce the concrete quality required by these specifications.
5. A minimum of a 4 cubic yard trial mixture containing all required admixtures shall be placed at the job site using the accepted methods of placing, finishing and curing. All applicable tests including slump, strength, water content, air content, permeability, and air content will be performed. The admixture manufacturer(s) and inspectors shall be present. The same testing should be done in the laboratory at the same time for comparison. A test sample should be done for each condition that is to be placed.
6. The Engineer of Record will be present at the conference. The Contractor shall notify the Engineer of Record at least 10 days prior to the scheduled date of the conference.

1.6 PROJECT CONDITIONS

A. The Contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Architect or Engineer of Record any condition which prevents this contractor from performing first class work.

B. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.

C. Protect adjacent finish materials against spatter during concrete placement.

D. Provide all barricades and safeguards at all pits, holes, shaft and stairway openings, etc., to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Take full responsibility for all safety precautions and methods.

E. Procedure of Work: The contractor shall keep themself constantly informed as to the progress of the work in the field, materials and workers ready to start work immediately when conditions of preceding work are available or ready,

wholly or in part, so as not to delay the progress of building work or to interfere with the progress of work of other contractors, and in any event the contractor shall, within 24 hours after notice from the Owner, proceed with such work as directed to maintain the uninterrupted progress of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct of plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection.

1. Use plywood complying with U.S. Product Standard PS-1 “B-B (Concrete Form) Plywood”, Class I, Exterior Grade or better mill oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Preference shall go to salvaged or re-used Dimensional Lumber. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Sustainability Requirements For Wood Used For Formwork

1. New Dimensional Lumber for Formwork: Provide wood certification documentation from the manufacturer/distributor, declaring conformance with Forest Stewardship Council (FSC) guidelines for certified wood building components The following independent certification organizations are accredited by the FSC and provide the manufacturer/distributor with documentation:

a. Scientific Certification Systems, Inc..
b. Smart Wood Certification Program: Rainforest Alliance

2. Salvaged or re-used Dimensional Lumber for Formwork: For wood salvage wood resources see GreenSpec.

3. If new dimensional Lumber is neither Certified nor salvaged: select regionally grown lumber with the lowest grade that meets performance requirements.

D. Form Coatings: Provide VOC compliant commercial formulation form- coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces. Use biodegradable form release agent listed below or equivalent made from soy or rapeseed oil.

1. “Clean Strip J1EF” Dayton Superior
2. “Soy Form Away” Cure & Seal by Natural Soy Products
3. “Bio-Form” Leahy-Wolf Company
4. “Duogard II” W. R. Meadows, Inc.

5. "Atlas Bio-Guard" Atlas Construction Supply, Inc.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Form Ties: Form ties and spreaders: prefabricated assemblies by Richmond; Superior, Dayton or approved equal. Wire ties shall not be used. Ties for foundation work shall be of snap design with removal cones and water seal washer.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615 M, Grade 60.

B. Weldable Reinforcing Bars: ASTM A 706/A 706M, Grade 60.

C. Non-magnetic Stainless Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60 (bars shall meet requirements of ASTM A 276, Type 316LN.

D. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) Class I (3.0 oz. zinc psf) hot-dip galvanized, after fabrication and bending.

E. Epoxy-Coated Reinforcing Bars: ASTM A 775 (as noted on plan and/or in section).

F. Steel Wire and Welded Wire Reinforcement: ASTM A 1064. Galvanized at exterior locations, conditions permanently exposed to weather and/or water, and where noted on drawings (plan and/or sections).

G. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 , plain-steel bars, cut true to length with ends square and free of burrs.

H. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 , plain-steel bars, ASTM A 775/A 775M epoxy coated.

I. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

J. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

K. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire reinforcement in place. Use wire bar type supports complying with CRSI specifications.

1. For epoxy coated reinforcement provide plastic protected chairs and plastic ties. All imperfections in the epoxy coating are to be repaired prior to placement of concrete.

a. Use recycled plastic rebar supports (give preference to local supplier if available). Subject to compliance with requirements, provide one of the following:

1) International Plastics Group

2) Eclipse Plastic

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2), at a spacing not to exceed 4'-0" on center in either direction.

2.3 CONCRETE MATERIALS

A. Portland cement: ASTM C 150, Types I, II, or I/II. Use one brand of cement throughout project, unless otherwise acceptable to Architect.

a. Fly Ash: Consider fly ash as a replacement for at least 25% (by weight) for Portland cement. All design mixes must be reviewed and approved by the Engineer of Record. Fly Ash shall not be used in conjunction with Ground Granulated Blast Furnace Slag.
b. Ground Granulated Blast Furnace Slag (GGBF): Consider GGBF as a replacement for at least 40% (by weight) of the Portland cement. All design mixes must be reviewed and approved by the Engineer of Record. GGBF shall not be used in conjunction with Fly Ash.
c. Pozzolans and Slags: These must be completely accounted for in the design mix. Mix design must meet minimum design requirements set in the contract documents. Additional admixtures may be required to meet early strength requirements and alternative cementitious material goals. If a "blended cement" is used which already contains a certain percentage of Pozzolans or Slags this content may offset or entirely satisfy the minimum percentage required.

1) Coal Fly Ash: ASTM C 618 (Class C or Class F): ASTM C 618 (Note: Class F fly Ash will require higher amounts or air entraining ad-mixtures than class C).
2) Blast Furnace Slag: ASTM C989
3) Silica Fume: ASTM C 1240
4) Rice Hull (or “husk”) Ash: ASTM C 618 Blended hydraulic cement, as defined by ASTM C 595 or ASTM C 1157

B. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.

1. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Architect.
2. Normal weight Fine Aggregate: washed, inert, natural or manufactured or combination thereof, sand conforming ASTM C33 gradation.
3. Normal weight Coarse Aggregate: well graded crushed stone or washed gravel conforming to ASTM C33, sizes 57 for foundations and 67 for slabs and structure.

a. Recycled crushed concrete aggregate in concrete mixes is only to be used with approval of Engineer of Record. Recycled aggregate shall be used only as a substitute for coarse aggregate and must also be washed and well-graded, conforming to ASTM C33.
b. For sub-base, slabs on grade and non-structural applications and Recycled Aggregate Materials are NOT required to meet the ASTM C 33 standard. In addition to concrete rubble, glass, porcelain, and tire chips can be used as filler material. Any inert material conforming to ASTM D1241 is acceptable for the applications described in this paragraph.

C. Lightweight Aggregates: Well-graded crushed expanded shale produced by rotary kiln method. Solite or equal, conforming to ASTM C330.

D. Water: Free from oils, acids, alkali, organic matter and other deleterious material to conform to ASTM C94. ASTM C94 for gray water use in the production of ready mixed concrete per approval by the Engineer of Record.

E. Air Entraining Admixture: ASTM C 260.

1. Liquid air entrainment: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	"Air Mix"	Euclid Chemical
b.	"AEA-92"	Euclid Chemical
c.	"Darex AEA"	W. R. Grace
d.	"MasterAir VR 10"	Master Builders

F. Water-Reducing Admixture: ASTM C 494.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	"MasterPolyheed 997"	Master Builders
b.	"Euclid MR"	Euclid Chemical
c.	"WRDA 64"	W. R. Grace.

G. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G and containing not more than 0.05 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	"Eucon 37, 1037 or Plastol 5000"	Euclid Chemical Co.
b.	"Rheobuild 1000"	Master Builders
c.	"MasterGlenium 7500"	Master Builders
d.	"Daracem-100"	W. R. Grace

H. Water Reducing, Non-Corrosive Accelerating Admixture: The admixture shall conform to ASTM C 494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non- corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Accelerating admixtures are not to be used as antifreeze agents. Accelerating admixtures are permitted only upon review by Engineer of Record.

1. Products: Subject to compliance with requirements, provide the following or equal approved by Engineer of Record:

a.	"Accelguard 80"	Euclid Chemical Co.
b.	"Daraset"	W. R. Grace
c.	"Pozzutec 20"	Master Builders.

I. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and contain not more than 0.05 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	"Eucon Retarder 75"	Euclid Chemical Co.

b.	"Pozzolith 100XR"	Master Builders.
c.	"Plastiment"	Sika Chemical Co.
d.	"Daratard"	W.R. Grace.

J. Microsilica Admixture shall be dry densified or slurry formed. Microsilica shall come from the same source throughout the project. If a single source cannot be maintained, laboratory testing of each new source shall be required before acceptance by the Engineer of Record at no cost to the owner.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	"Emsac F 100"	Elkem Chemical, Inc.
b.	"Eucon MSA"	Euclid Chemical Co.
c.	"Force 10,000"	W. R. Grace

K. Prohibited Admixtures: Calcium chloride, thyocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

L. Certification: Written conformance to the above-mentioned requirements and the chloride ion content of admixtures will be required from the admixture manufacturer prior to mix design review by the Engineer of Record.

M. Macro-Fibers: Engineered macro-synthetic fibers.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	“Tuf-Strand SF”	Euclid Chemical Co.
b.	“Fibermesh 650”	Propex Concrete Systems
c.	“Strux 90/40”	W.R. Grace
d.	“Forta-Ferro”	Forta

N. Micro-Fibers: Engineered micro-synthetic fibers.

1. Products: Subject to compliance with requirements, provide the following or equal approved by Engineer of Record:

a.	"Fiberstrand N":	Euclid Chemical Co.
b.	"Fibermesh 150":	Propex Concrete Systems
c.	“Ultra-Net”	Forta

O. Natural Fiber Reinforced Concrete: Natural fiber reinforced concrete is permitted only upon review by Engineer of Record. Refer to ACI 544.1R, chapter 5

P. Corrosion Inhibitor: 30% calcium nitrite (where called for in the specifications or on the drawings). Subject to compliance with requirements, provide the following at 3 gal/cy:

1.	“Eucon CIA	Euclid Chemical
2.	“DCI”	W. R. Grace
3.	“Rheocrete CNI”	Master Builders.

Q. Contractor will be required to provide information demonstrating successful use in prior placement involving all admixtures.

2.4 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal approved by Engineer of Record:

   a. Greenstreak
   b. Williams Products, Inc.

2. Profile: As indicated.
3. Dimensions: 4 inches by 3/16 inch thick; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal approved by Engineer of Record:

   a. BoMetals, Inc.
   b. Greenstreak
   c. Paul Murphy Plastics Company
   d. Vinylex Corp.

2. Profile: As indicated.
3. Dimensions: 4 inches by 3/16 inch thick; nontapered.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

   a. "MiraSTOP" Carlisle Coatings & Waterproofing, Inc.
   b. "Waterstop-RX" CETCO
   c. "Conseal CS-231" Concrete Sealants Inc.
   d. "Swellstop" Greenstreak
   e. "Hydro-Flex" Henry Company, Sealants Division
   f. "Earth Shield Type 20" JP Specialties, Inc.

2.5 GROUT

A. Non-Shrink, Non-Metallic Grout: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 4' x 4' base plate.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

   a. "Euco-NS" Euclid Chemical Co.

b. "Five Star Grout" U.S. Grout Corp.
c. "Masterflow 713 Plus" BASF

B. High Flow Grout: Where high fluidity and/or increased placing time is required, use high flow grout. The factory pre-mixed grout shall conform to ASTM C1107, "Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 18" x 36" base plate.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. "Euco Hi-Flow Grout" Euclid Chemical Co.
b. "Masterflow 928" BASF
c. “Five Star Fluid Grout 100” Five Star

2.6 RELATED MATERIALS

A. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 1241, Size 57, with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing a No. 8 sieve.

B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 1241, Size 10, with 100 percent passing a 3/8 inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

C. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.

D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

E. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Waterproof paper
b. Polyethylene film
c. Polyethylene-coated burlap

F. Curing Compounds: Curing compounds may be used to aid in preventing the loss of moisture, other methods may be acceptable pending review. The compound shall conform to ASTM C 309. Limit VOC content to 130 g/L. Use water-based curing compound. For surfaces receiving both a curing compound and additional flooring, verify that the curing compound and additional flooring are compatible.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. “SealTight 1100” W.R. Meadows
b. “Kurez W VOX” Euclid Chemical Co.
c. “Everclear VOX” Euclid Chemical Co.

d. ‘VOCOMP-25” W.R. Meadows

G. Curing & Sealing Compounds: Only specify for slabs that will remain exposed, i.e. will not receive additional flooring. The compound shall conform to ASTM C1315. Limit VOC content to 130 g/L. Use water-based curing compound.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. “Everclear VOX” Euclid Chemical Co.
b. “VOCOMP-25” W.R. Meadows

H. Sealers/Hardeners: For use on concrete surfaces that will remain exposed. Slabs that will receive additional flooring do not require sealing or hardening. Sealers and hardeners must not yellow under ultra violet light after 500 hours of test in accordance with and have a maximum moisture loss of 0.039 grams per sq. cm. when applied at a coverage rate of 250 sq. ft. per gallon. Limit VOC content to 130 g/L. Use water- or vegetable-based product.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. “Kure-N-Harden” BASF

I. Evaporation Retardant:

1. Products Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. "Eucobar" Euclid Chemical Co.
b. "Confilm" BASF

J. Certify that all curing compounds, sealers and hardeners are compatible with all adhesive products intended for attaching co-lateral floor material. In conformance with ASTM F 710, coordination with flooring manufacturer is required to insure concrete coatings will not obstruct the bond between the concrete and the adhesive. Insure coatings and adhesives are “benignly compatible” -- in other words, do not combine substances whose constituents are reactive. Reactivity releases VOCs and /or other toxic fumes.

K. Crack Sealer: Elastomeric liquid crack sealer resistant to water, gasoline, oil and salts.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. "Eucolastic 1NS" Euclid Chemical Co.
Maximum allowable depth of this product is ½”.

L. Bonding Admixture: The compound shall be a latex, non-rewettable type.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a. "Flex-Con" Euclid Chemical Co.
b. "SBR Latex" Euclid Chemical Co.

M. High Strength Polymer Repair Mortar: For form and pouring or large horizontal repairs, provide the flowable on-part, high strength repair mortar.

1. Products: subject to compliance with requirements, provide the following or equal approved by Engineer of Record:

a.	"Eucocrete"	The Euclid Chemical Co.
b.	"Euco Speed MP" (Cold Weather)	The Euclid Chemical Co.
c.	“Emaco R”	Master Builders.

N. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

a.	“Daraweld C”	W.R. Grace

O. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Type IV for bonding hardened concrete to hardened concrete, and Type V for bonding freshly mixed concrete to hardened concrete.

P. Reglets: Fabricate reglets of not less than 0.022 inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

Q. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

R. Vapor Barrier: Provide vapor barrier which conforms to ASTM E 1745, Class A or B. The membrane shall have a water-vapor permeance rate no greater than 0.012 perms when tested in accordance with ASTM E 154, Section 7. The vapor barrier shall be placed over prepared base material where indicated below slabs on grade. Vapor barrier shall be no less than 10 mil thick in accordance with ACI 302.1R. Preferred vapor barriers will be manufactured from post-consumer recycled polymers.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	“Stego Wrap (15 mil) Vapor Barrier”	Stego Industries LLC
b.	“Griffolyn Vaporguard”	Reef Industries
c.	“Premoulded Membrane with Plastmatic Core”	W.R. Meadows.

S. Expansion Joint Filler: ASTM D 1751.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Engineer of Record:

a.	“Homex 300”	Homasote Company
b.	“Standard Cork Expansion Joint Filler”	APS Cork
c.	“Fibre Expansion Joint”	W.R. Meadows

T. Water: Potable.

2.7 PROPORTIONING AND DESIGN OF MIXES

A. Preparation of Design Mixes

1. All mix designs shall be proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and prepared by a licensed testing laboratory approved by the owner, but paid for by the contractor. Submit mix designs on each class of concrete for review.
2. If previously used mixes are submitted, all materials shall be from the same sources and with the same brand names as the previously utilized mix.
3. If trial batches are used, the mix design shall be prepared by an independent testing laboratory and shall achieve an average compressive strength 1200 psi higher than the specified strength. This over-design shall be increased to 1.10f'c+700 psi when concrete strengths greater than 5000 psi are used.
4. The proposed mix designs shall be accompanied by complete standard deviation analysis or trial mixture test data.

B. Submit each proposed mix to the Architect and Structural Engineer for review at least 5 days prior to the pre-concrete conference. Do not begin concrete production until Architect and Engineer of Record has reviewed and approved mixes.

1. Submit Test reports for any pozzolans or slags indicating compliance with ASTM C 618 or ASTM C 989, respectively.
2. Provide cut sheets clearly indicating the percentages of pozzolans or slags used in the mix design as replacement for Portland cement. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the percentage.
3. Test reports for recycled aggregate indicating compliance with ASTM C 33. Provide cut sheets clearly indicating the percentage of aggregates used that are recycled. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and source or sources of the material.
4. Provide cut sheets clearly indicating the percentage of sub-base and filler aggregate materials that are recycled. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and source or sources of the material.

C. Design mixes to provide concrete with strength as indicated on drawings and schedules.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Architect and Engineer of Record. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect and Engineer of Record before using in work.

E. Admixtures:

1. Use water-reducing admixture or high range water-reducing admixture (superplasticizer) in all concrete as required for placement and workability.
2. Use non-corrosive, non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50^{o}F (10^{o}C).
3. Use high-range water-reducing admixture in pumped concrete, architectural concrete, parking structure slabs, fiber concrete, concrete required to be watertight, concrete with ultimate strength of 5,000 psi or more, and concrete with water/cement ratios below 0.50.
4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within following limits:

    a. Concrete structures and slabs exposed to freezing and thawing or deicer chemicals.
        1) 1-1/2” maximum aggregate: 4.5 percent (moderate exposure); 5.5 percent (severe exposure)
        2) 1” maximum aggregate: 4.5 percent (moderate exposure); 6 percent (severe exposure)

3) ¾" maximum aggregate: 5 percent (moderate exposure); 6 percent (severe exposure)
4) ½" maximum aggregate: 5.5 percent (moderate exposure); 7 percent (severe exposure)
5) 3/8" maximum aggregate: 6 percent (moderate exposure); 7.5 percent (severe exposure)

b. Other Concrete: (not exposed to freezing, thawing, or hydraulic pressure): 2 percent to 4 percent air.
c. Interior concrete to receive hard troweling shall not be air entrained unless specifically approved by the Engineer.

5. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:

1. Concrete for precast slabs, precast beams, structural topping slab, caisson caps, caissons, poured in place slabs and grade beams, columns and walls, over water, on ground or exposed to weather: W/C 0.40 maximimum.
2. Concrete on metal deck:

a. With specified minimum compressive strength not greater than 5,000 psi: 0.40.
b. With specified minimum compressive strength not greater than 7,000 psi: 0.35.

3. "Quick Dry" Concrete: 0.40.
4. Subjected to freezing and thawing; W/C 0.45.
5. Subjected to deicers/watertight: W/C 0.45.
6. Reinforced concrete subjected to brackish water, salt spray or deicers; W/C 0.40.

G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramp slabs and sloping surfaces: Not more than 3".
2. Reinforced foundation systems, including mud slabs below hydrostatic slabs: Not less than 1" and not more than 3".
3. Concrete containing HRWR admixture (superplasticizer): Not more than 9" unless otherwise approved by the architect. The concrete shall arrive at the job site at a slump of 2" to 3" (3" to 4" for concrete receiving a "shake-on" hardener or lightweight concrete), be verified, then the high-range water-reducing admixture added to increase the slump to the approved level.
4. Other Concrete: Not less than 1" or more than 4".

H. Chloride Ion Level: Chloride ion content of aggregate shall be tested by the laboratory making the trial mixes. The total chloride ion content of the mix including all constituents shall not exceed the limitations set forth in Table 4.4.1 of ACI 318 for concrete subjected to deicers or exposed to chloride in service (0.15% chloride ions by weight of cement).

2.8 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce maximum mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce maximum mixing and delivery time to 60 minutes.

D. No water shall be added after mixing to concrete containing HRWR (Superplasticizer). If loss of slump occurs, the concrete treated with HRWR may be redosed as long as a "flash set" has not occurred. Redosage procedures must be discussed and approved by the Engineer of Record and the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 INSPECTION

A. Examine all work prepared by others to receive work of this section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.3 CONCRETE

A. Concrete shall develop the minimum compressive strengths shown on drawings at 28 days when sampled and tested in accordance with ASTM C 31 and C 39 with the maximum slump in accordance with the approved mix design.

B. Concrete shall be in accordance with the requirements and specifications of "Building Code Requirements for Structural Concrete" as modified by the building code noted above.

C. Fly Ash Concrete & Slag Concrete: Concrete mixes containing high volumes of fly ash or Slag have slower set times and may take up to 56 days to reach full strength. The Engineer of Record, agency responsible for concrete mix design, the architect and the concrete subcontractor must coordinate to ensure that the form stripping schedule is consistent with the ability of the structure to support itself and all imposed construction loads.

3.4 FORMS

A. Design formwork to maximize its reusability, reduce resources devoted to formwork construction and minimize waste generated. Where appropriate choose alternative formwork systems (refer to sections listed above).

B. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shapes, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 347. Provide Class A tolerances for concrete exposed to view. Provide Class C tolerances for other concrete surfaces.

C. Design formwork to be readily removable without impact, shocks or damage to cast-in-place concrete surfaces and adjacent materials.

D. Construct forms to size shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back- up at joints to prevent leakage of cement paste.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, to prevent swelling and for easy removal.

F. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

G. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.5 VAPOR BARRIER INSTALLATION

A. Examine the condition of porous fill and remedy any unsatisfactory portions prior to installing vapor barriers.

B. Sub-base material to be per above sections.

C. Following leveling and tamping of sub-base for slabs on grade, place vapor barrier sheeting with longest dimension parallel with direction of pour.

D. Lap joints 6" and seal with appropriate tape.

E. After placement of moisture barrier, cover with granular material and compact to depth as shown on drawings.

F. Avoid cutting or puncturing vapor barrier during reinforcement placement and concreting operations.

3.6 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverage's for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

F. Micro-Fibers: All concrete where indicated on the drawings shall contain the specified micro-fibers. Length shall be per the manufacturer's specification. The dosage rate shall be 1.0 – 1.6 lbs per cubic yard per the manufacturer's specification. Submit proposed dosage rate to Engineer of Record for review prior to concrete placement.

G. Macro-Fibers: All concrete where indicated on the drawings shall contain the specified macro-fibers. Length shall be per the manufacturer's specification. The dosage rate shall be 3.0 – 5.0 lbs per cubic yard per the manufacturer's specification. Submit proposed dosage rate to Engineer of Record for review prior to concrete placement.

H. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars where specified by the Architect or Engineer of Record, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.

I. Epoxy-coated reinforcing bars shall be fastened with nylon- , epoxy- , or plastic-coated tie wire, or other acceptable materials.

J. Repair of damaged epoxy-coating: When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

K. Unless permitted by the Engineer of Record, epoxy-coated reinforcing bars shall not be cut in the field. When epoxy-coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

3.7 JOINTS

A. Construction Joints: Locate and install construction joints as indicated, or if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Architect.

B. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions, using manufacturer's specified welding irons.

E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals and elsewhere as indicated.

1. Joint filler and sealant materials are specified in the section for "Related Materials"

F. Contraction (Control) Joints in Slabs-on-Ground: Maximum joint spacing shall be 36 times the slab thickness unless otherwise noted on the drawings. The dry cut saw shall be used immediately after final finishing and to a depth of 1-1/4". A conventional saw shall be used as soon as possible without dislodging aggregate and to a depth of 1/4 slab thickness.

1. Joint sealant material is specified in the section for “Related Materials”.

3.8 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

C. Embedded Plates at Foundation Walls: Install plate at top of forms so that exterior face of steel plate is level and plumb. Use construction documents for locations, sizes and elevations.

3.9 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. If form-release compound is required, coat contact surfaces of forms with a form-coating compound *before* reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, and amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in- place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.10 CONCRETE PLACEMENT

A. Ready-mix concrete shall comply with the requirements of ASTM C 94 and ACI 304. All plant and transporting equipment shall comply with the concrete plant standards and truck mixer and agitator standards of the National Ready Mix Concrete Association.

B. Cold weather mixing procedures shall be submitted to the architect for approval.

C. Notify Architect and Owner’s Inspector at least 36 hours (1 1/2 regular working days) before each pour so that forms and reinforcing may be examined. Do not place concrete until inspection has been made or waived.

D. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

E. General: Comply with ACI 304 “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete,” and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

F. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 18" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Use internal vibrators penetrating both the top and preceding layers.

G. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

H. Use and type of vibrators shall conform to ACI 309 “Recommended Practice for Consolidation of Concrete.” Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

I. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

J. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

K. Slabs: Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedge, bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. See also "MONOLITHIC SLAB FINISHES" below.

L. Maintain reinforcing in proper position during concrete placement operations.

M. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40^{o}F (4^{o}C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50^{o}F (10^{o}C), and not more than 80^{o}F (27^{o}C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Use only a non-corrosive, non-chloride accelerator. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are NOT permitted.
4. Care must be taken to store water-based curing and sealing compounds where they will not freeze. In most cases, they cannot be reconstituted after thawing.

N. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90^{o}F (32^{o}C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of

ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.

3.11 FINISH OF FORMED SURFACES

A. Concrete mixes containing pozzolans or slags do not set at the same rate or with the same bleed water characteristic as plain Portland cement. Therefore attention must be directed to the proper procedures. Refer to ACI 232.2R and ACI 301.

B. Rough Form Finish: For formed concrete surface not exposed-to- view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

C. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed. Follow all requirements in ACI 301, Chapter 10 for smooth form finish. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction.

3.12 FLOOR FLATNESS/LEVELNESS TOLERANCES

A. FF defines the maximum floor curvature allowed over 24 in. Computed on the basis of successive 12 in. (300 mm) elevation differentials, FF is commonly referred to as the "Flatness F-Number".

B. FL defines the relative conformity of the floor surface to a horizontal plane as measured over a 10 ft. (3.05 m) distance commonly referred to as the "Levelness F-Number".

C. All floors shall be measured within 72 hours of being poured and in accordance with ASTM E 1155 "Standard Test Method for Determining Floor Flatness and Levelness Using the "F Number" System (Inch-Pound Units).

D. All slabs shall achieve the specified overall tolerance. The minimum local tolerance (1/2 bay or as designated by the architect) shall be 2/3 of the specified tolerances.

E. All elevated slabs shall achieve the specified FL tolerance before the removal of the forms.

F. All slabs on metal deck shall achieve the specified FF.

3.13 MONOLITHIC SLAB FINISHES

A. Float Finish: Apply float finish to slabs at crawl spaces, unless otherwise noted. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Cut

down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Surface shall achieve an FF 20 - FL 17 tolerance.

B. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system, unless otherwise noted. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface leveled to an FF 25/ FL 20 tolerance (FL17 for elevated slabs). Grind smooth surface defects, which would telegraph through applied floor covering system.

C. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, and slab surfaces which are to be covered with membrane or elastic waterproofing, or sand-bed terrazzo, and as otherwise indicated, apply single trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction

D. Sealers, Hardeners and Liquid Densifiers: Apply a coat of the specified compound to all EXPOSED interior concrete floors where indicated on the drawings. This surface must be continuously moist cured by a method satisfactory to the Architect. Apply and mechanically scrub compound into the floor in strict accordance with the manufacturer's printed instructions.

3.14 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
3. In order to avoid plastic or drying shrinkage cracks during warm, dry or windy weather, ACI 302 and ACI 308 shall be followed using wind breaks and sun shades when recommended. Evaporation retardant shall be as specified in Section 2.04.
4. Care must be taken to store water based curing and sealing compounds where they will not freeze. In most cases, they cannot be reconstituted after thawing.

B. Curing Methods: Perform curing of concrete by moisture curing, moisture-retaining cover curing, curing and sealing compound, and by combinations thereof, as herein specified.

1. Provide moisture curing by following methods.

   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

2. Provide moisture-retaining cover curing as follows:

a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Provide curing and sealing compound to exposed interior slabs not receiving additional flooring. A clear curing and sealing compound shall be used on exterior slabs, sidewalks and curbs not receiving a penetrating sealer.
4. Use the specified curing compound on surfaces to be covered with finish or coating material applied directly to concrete, such as liquid densifier/sealer, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials. Apply compound in accordance with manufacturer's direction.

C. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of the specified curing compound or a continuous moist curing method approved by the architect.

E. Certify that all curing compounds, sealers and hardeners are compatible with all adhesive products intended for attaching co-lateral floor material. In conformance with ASTM F710, coordination with flooring manufacturer is required to insure concrete coatings will not obstruct the bond between the concrete and the adhesive. In addition, insure coatings and adhesives are "benignly compatible" -- in other words, do not combine substances whose constituents are reactive.

F. Sealer and Dustproofer: Apply a second coat of the specified curing and sealing compound to exposed interior slabs not subjected to vehicular traffic, noted on the drawings. These slabs must have received an initial coat of the curing and sealing compound.

3.15 SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Extend shoring from ground to roof for structures 4 stories or less, unless otherwise permitted.

C. Extend shoring generally at least 4 floors under floor or roof being placed for structures over 5 stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this levels in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure. Contractor shall provide the services of a registered Professional Engineer to design the shoring, and determine timing of removal.

D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

E. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.16 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 12 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28-days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.17 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are intended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Architect.

3.18 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in- place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Grout base plates and foundations as indicated using specified free-flowing non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

E. Where high fluidity and/or increased placing time is required use the specified high flow grout. This grout shall be used for all base plates larger than 10 square feet.

F. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screeds, tamp, and finish concrete surfaces as scheduled.

G. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.19 CONCRETE SURFACE REPAIRS

A. Prior to all repairs, an as-built condition sketch and method of repair must be submitted to the Architect and Engineer of Record for review and approval.

B. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

C. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with a bonding grout containing the specified bonding admixture. Place patching mortar after while bonding grout is still tacky.

D. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

E. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or pre-cast cement cone plugs secured in place with bonding agent.

F. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

G. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for tureens of slope, in addition to smoothness, using a template having required slope.

H. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

I. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days, except at hydrostatic slabs.

J. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. The specified underlayment compound or repair toping may be used when acceptable to Architect.

K. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

L. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cutout holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after

bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

M. Structural Repair: All structural repairs shall be made with prior approval of the Engineer of Record as to method and procedure, using the specified polymer repair mortar and/or specified epoxy adhesive. Where epoxy injection procedures must be used, an approved low viscosity epoxy made by the manufacturers previously specified shall be used. In addition, all cracks shall be filled with the specified crack sealer or other method as approved by the Engineer of Record. All garage slabs shall be repaired prior to the slab being treated with the specified penetrating anti-spalling sealer.

N. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material. Underlayment application shall achieve the tolerances specified in "MONOLITHIC SLAB FINISHES" above.

O. Specified Polymer Horizontal Repair Mortar: All exposed floors shall be leveled, where required, with the specified self-leveling repair topping.

P. Repair Methods not specified above may be used, subject to acceptance of Architect.

3.20 FOUNDATION WALLS

A. The contractor shall form and leave openings in walls as shown on drawings and approved shop drawings for work of other contractors. These openings shall be temporarily closed and when so directed, the contractor shall point up in solid and neat manner with waterproofed cement.

3.21 WORK IN CONNECTION WITH OTHER TRADES AND CONTRACTS

A. Sleeves, pockets, openings, etc., shall be set in the concrete walls and arches as required for the mechanical trades as shown on approved shop drawings; these shall be encased or built into the concrete work and shall be properly placed and secured in position in the forms before concrete is placed.

B. Provide all chases, pipe slots, etc., required for the mechanical trades (see mechanical drawings), constructed as shown on the approved shop drawings.

C. Leave temporary access panels where required to install mechanical equipment as required by trade affected. Panels shall be formed with construction joints as specified. Details for such panels shall be submitted to Architect for approval.

D. Coordinate all penetrations, cutting, and patching with waterproofing contractor.

3.22 CUTTING AND PATCHING

A. Contractor for concrete work shall be responsible for all cutting, removing and patching work where concrete surfaces are not installed within the limits shown on the drawings or specified herein. All such work shall meet with the approval of the Architect or Engineer of Record.

B. Where cutting and patching is required to accommodate the work of other subcontractors, such cutting shall be done at the expense of said subcontractors but shall be performed by the contractor for concrete work.

C. The location and extent of cutting in completed concrete work and the patching thereof shall meet with the approval of the Architect or Engineer of Record.

3.23 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Owner will employ a testing laboratory to perform tests and to submit test reports.

B. Provide special inspections per the applicable Building Code and the requirements of all applicable ACI standards.

C. At locations previously indicated in this specification and on the contract drawings, verify the use of non-magnetic materials. No magnetic materials are permitted in locations where prohibited by this specification or the contract drawings.

D. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of discharge for each truck; additional tests when concrete consistency seems to have changed.

3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each truck of air-entrained concrete.
4. Concrete Temperature: Test hourly when air temperature is 40^{o}F (4^{o}C) and below, and when 80^{o}F (27^{o}C) and above; and each time a set of compression test specimens made.
5. Compression Test Specimen: ASTM C 31; one set of 5 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
6. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 25 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimens tested at 7 days, three specimens tested at 28 days, and one specimens retained in reserve for later testing if required.

    a. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
    b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
    c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

7. Water Cementitious Ratio Test: Check water content of concrete in accordance with AASHTO T 318 “Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying”. Frequency of this test shall be the same as that of compressive strength tests, noted above.
8. Floor Preparation to Receive Resilient Flooring: For any concrete that receives resilient flooring, test concrete in accordance with ASTM F 710 prior to acceptance by owner.
9. Test results will be reported in writing to Architect, Engineer of Record, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

a. Non Compliance: All test reports indicating non-compliance shall be faxed immediately to all parties on the test report distribution list and the hard copies submitted on different colored paper.
b. Nondestructive Testing: Windsor probes, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

10. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

3.24 WASTE MANAGEMENT

A. Separate and recycle waste materials to the maximum extent feasible.

B. Collect cut off steel and discarded reinforcement steel and place in area for recycling.

C. Place materials defined as hazardous or toxic waste in designated containers.

D. Use trigger operated spray nozzles for water hoses and closed loop system to reduce water consumption.

E. Reusable forms should be cleaned immediately after removal and non-reusable forms recycled to the maximum extent economically feasible.

F. Incorporate crushed concrete or masonry materials in sub-base to the maximum extent feasible in accordance with sub-base specifications.

G. Before concrete pours, designate location or uses for excess concrete. Options include:

1. Additional paving
2. Post footing anchorage
3. Landscaping -- site concrete features
4. Flowable fill

H. To avoid contamination of the local landscape, before concrete pours, designate a location for cleaning out concrete trucks where run-off can be contained, reused or incorporated. Options include:

1. Company owned site for that purpose
2. On-site area to be paved later in project

END OF SECTION

SECTION 035433

POLISHED CONCRETE FINISHING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the polished concrete floor finish.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.4 REFERENCES

A. American Concrete Institute (ACI): ACI 302.1R Guide for Concrete Floor and Slab Construction.

B. ASTM International:

1. ASTM C 171, Standard Specification for Sheet Materials for Curing Concrete.

2. ASTM C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.

3. ASTM D 1308, Standard Test Method for Effect of Household Chemical on Clear and Pigmented Organic Finishes.

4. ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slab Using In-Situ-Probes.

5. ASTM F 710, Standard Test Method for pH.

C. National Floor Safety Institute (NFSI): NFSI Test Method 101-A Standard for Evaluating High-Traction Flooring Materials, Coatings, and Finishes.

1.5 PERFORMANCE REQUIREMENTS

A. Provide polished flooring that has been selected, manufactured and installed to achieve the following:

1. Abrasion Resistance: ASTM C 779, Method A, high resistance, no more than 0.008" (0.20 mm) wear in 30 minutes.

2. Reflectivity: Increase of 35% as determined by standard gloss meter.

3. Waterproof Properties: Rilem Test Method 11.4, 70% or greater reduction in absorption.

4. Dynamic Coefficient of Friction: DCOF range of 0.35 to 0.45 under wet conditions when measured according to ANSI B101.3.

1.6 SUBMITTALS

A. Shop Drawings: Provide information on shop drawings as follows:

1. Typical layout including dimensions and floor grinding schedule.

2. Hardener, sealer, densifier in notes.

B. Product Data: Submit product data, including manufacturer's SPEC-DATA® product sheet, for specified products.

1. Material Safety Data Sheets (MSDS).

2. Preparation and concrete grinding procedures.

3. Colored Concrete Surface, Dye Selection Guides.

C. Quality Assurance for Submittals:

1. Technicians and supervisors must be CPAA certified as a Craftsman or Master Craftsman; submit letter to this effect to the Architect.

2. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties as cited in 1.5 Performance Requirements.

3. Certificates:

a. Product certificates signed by manufacturer certifying that materials comply with specified performance characteristics and criteria and physical requirements.
b. Letter of certification from the National Floor Safety Institute confirming that the system has been tested and has passed Phase Two Level of certification when tested by Method 101-A.
c. Current contractor's certificate signed by manufacturer declaring contractor is an approved installer of polishing system.

4. Manufacturer's installation instructions.

D. Warranty: Submit warranty documents specified.

E. Provide the following:

1. Manufacturer's instructions on maintenance renewal of applied treatments.

2. Protocols and product specifications for joint filing, crack repair and/or surface repair.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installer must have a minimum of five (5) years' experience installing polished concrete floors and must be trained and certified by both the equipment and chemical manufacturer to process polished concrete and be certified by the Concrete Polishing Association of America (CPAA) as noted in Article 1.6, Para. D.1 herein.

2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

B. Regulatory Requirements: NFSI Test Method 101-A Phase Two Level High Traction Material.

C. Mock-Ups: Provide 100 sf sample panel at job site, at location as directed by the Architect, installed under conditions similar to those which will exist during actual placement.

1. Mock-up will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, color selection and shine.

2. Allow 24 hours for inspection of mock-up before proceeding with work.

3. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

D. Preinstallation Meetings: Conduct a preinstallation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Other items for agenda of preinstallation meetings shall include, but not be limited to, the following:

1. Environmental requirements.

2. Scheduling and phasing of work.

3. Coordinating with other work and personnel.

4. Protection of adjacent surfaces.

5. Surface preparation.

6. Repair of defects and defective work prior to installation.

7. Cleaning.

8. Installation of polished floor finishes.

9. Application of liquid hardener, densifier.

10. Protection of finished surfaces after installation.

E. Coordination with Section 033000:

1. Concrete to receive polished finish shall not contain admixtures, plasticizers, slag, or other products replacing Portland cement in the mix.

2. Concrete to receive polished finish shall be wet cured in accordance with ACI 308, "Guide to Curing Concrete."

3. Concrete to receive polished finish shall not contain any air-entraining agents.

4. Floor Flatness and Levelness: Slab to receive polished concrete must conform to the following:

    a. Flatness: Overall value 50; minimum local value 35.
    b. Levelness: Overall value 30; minimum local value 20.

5. Conform to the minimum recommendations of CPAA.

1.8 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials in manufacturer's original packaging with identification labels and seals intact.

B. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

2. Protect concrete slab.

    a. Protect from petroleum stains during construction.
    b. Diaper hydraulic power equipment.
    c. Restrict vehicular parking.
    d. Restrict use of pipe cutting machinery.
    e. Restrict placement of reinforcing steel on slab.
    f. Restrict use of acids or acidic detergents on slab.

1.9 PROJECT CONDITIONS

A. Ambient Conditions: Comply with manufacturer's written recommendations.

1.10 SEQUENCING

A. Sequence With Other Work: Comply with manufacturer's written recommendations for sequencing construction operations.

1.11 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, 10-year finish warranty, commencing on the date of acceptance by the Owner, executed by an authorized company official. Manufacturer's warranty is in addition to, and does not limit, other rights Owner may have under Contract Documents.

1.12 EXTRA MATERIALS

A. Contractor to provide maintenance materials to allow for 5% of materials installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Ensure manufacturer has minimum 5 years' experience in manufacturing components similar to or exceeding requirements of project.

2.2 POLISHED CONCRETE FINISHING PRODUCTS

A. Manufacturer: L & M Construction Chemicals, Inc., or approved equal.

1. Contact: 14851 Calhoun Rd., Omaha, NE 68152-1140; Telephone: (800) 362-3331, (402) 453-6600; Fax: (402) 453-0244; website: www.LMCC.com, www.fgs-permashine.com; E-mail: info@lmcc.com

B. All chemicals used must have a pH value of 11.0 or less when tested per ASTM F 710, and shall be 100% reactive, non-resinous, water soluble, and not considered "hazardous waste."

C. Products/Systems:

1. Hardener, Sealer, Densifier: Proprietary, water-based, odorless liquid, VOC-compliant, environmentally-safe chemical hardening solution leaving no surface film.

a. Acceptable Material: L & M Construction Chemicals, Inc., "FGS Hardener Plus."

2. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.

a. Acceptable Material: L & M Construction Chemicals, Inc., "Joint Tite 750."

3. Oil-Repellent Sealer: Ready to use, silane, siloxane and fluoropolymers blended water-based solution sealer, quick drying, low-odor, oil and water repellent, VOC-compliant, and compatible with chemically hardened floors.

a. Acceptable Material: L & M Construction Chemicals, Inc., "Petrotex."

4. Concrete Dyes: Fast-drying dye, packaged in premeasured units ready for mixing with VOC-exempt solvent; formulated for application to polished cementitious surfaces.

a. Acceptable Material: L & M Construction Chemicals, Inc., "Vivid Concrete Dyes."

5. Cleaning Solution: Proprietary, mild, highly-concentrated liquid concrete cleaner and conditioner containing wetting and emulsifying agents; biodegradable, environmentally safe and certified High Traction by National Floor Safety Institute (NFSI).

a. Acceptable Material: L & M Construction Chemicals, Inc., "FGS Concrete Conditioner."

6. Finish: Finish to match approved sample and mock-up.

a. Meeting Level 80 Reflection Sheen when measured according to ASTM D 4039.
b. Meeting Level 20 Reflective Clarity when measured according to ASTM D 5767.

c. Level 2 Satin Honed with gloss reading at 40-50%.
d. Aggregate exposure B - Fine Aggregate.

7. Color: As selected by the Architect.

2.3 SOURCE QUALITY CONTROL

A. Ensure concrete finishing components and materials are from single manufacturer.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, and product carton installation instructions.

B. Use only manufacturer's certified installers.

3.2 EXAMINATION

A. Site Verification of Conditions

1. Verify that concrete substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with concrete finishing manufacturer's instructions prior to installation of concrete finishing materials.

2. Concrete substrates to receive polished concrete finish must have moisture level below acceptable limits of the manufacturer when tested per ASTM F 2170. Results of such tests must be submitted to the manufacturer, who shall verify same in writing to the Architect.

B. Verify Concrete Slab Performance Requirements:

1. Verify concrete is fully cured to 28-day minimum 3500 psi strength.

2. Verify concrete surfaces received a hard steel-trowel finish (minimum 3 passes) during placement.

3.3 PREPARATION

A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.

B. Examine surface to determine soundness of concrete for polishing.

C. Contractor shall remove surface contamination.

3.4 INSTALLATION

A. Floor Surface Polishing and Treatment

1. Provide polished concrete floor treatment using wet grind process for entire slab indicated on drawings, wall edge to wall edge. For work immediately adjacent to walls and obstructions, use hand held equipment. Provide consistent finish in all contiguous areas.

2. Apply floor finish prior to installation of fixtures and accessories.

3. Diamond polish concrete floor surfaces with power disc machine recommended by floor finish manufacturer, capable of generating 600 to 1200 revolutions per minute with sufficient head pressure of not less than 20 lbs. Sequence with coarse to fine grit using wet method.

   a. Comply with manufacturer's recommended polishing grits for each sequence to achieve desired high gloss finish. Level of sheen shall match that of approved sample and mock-up.
   b. All concrete surfaces shall be as uniform in appearance.

4. Dyed and Polished Concrete

   a. Locate demarcation line between dyed surfaces and other finishes.
   b. Polish concrete to final finish level.
   c. Apply diluted dyes to polished concrete surface.
   d. Allow dye to dry.
   e. Remove residue with dry buffer; reapply as necessary for desired result.

5. Apply FGS Hardener Plus, Hardener, Densifier as follows:

   a. First coat at 250 ft^2/gal.
   b. Second coat at 350 ft^2/gal.
   c. Follow manufacturer's recommendations for drying time between successive coats.

6. Remove defects and repolish defective areas.

7. Finish edges of floor finish adjoining other materials in a clean and sharp manner. Finish to edge at wall.

3.5 ADJUSTMENTS

A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.

B. Fill joints flush to surface.

3.6 FINAL CLEANING

A. Mechanically scrub treated floors for seven days with soft to medium pads with approved cleaning solution.

B. Upon completion, General Contractor must remove surplus and excess materials, rubbish, tools and equipment.

3.7 PROTECTION

A. Protect with EZ Cover by McTech Corp., or comparable product.

   1. Contact: Phone: (866) 913-8363; website: www.ezform.net

END OF SECTION

DIVISION 04
MASONRY

SECTION 042000

UNIT MASONRY

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the unit masonry work as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Concrete block foundation walls.
2. Exterior face brick veneer.
3. Metal joint reinforcing, anchors, ties, weeps, closures and related accessories for masonry.
4. Control and expansion joints in masonry, filled with joint fillers.
5. Through-wall flashing.
6. Cavity drainage material.
7. Polymer-modified masonry waterproofing.
8. Chases, recesses, pockets and openings in masonry as required for installation of work by others.
9. Building in of items furnished by others into masonry, including access doors, door frames, anchors, sleeves and inserts, and other similar items to be embedded in masonry.
10. Grouting in of metal items built into masonry work.
11. Protection, pointing and cleaning of masonry.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Cold-Formed Metal Framing - Section 054000.

C. Steel lintels - Section 055000.

D. Thermal Insulation - Section 072100.

E. Sheet Metal Flashing - Section 076200.

F. Firestops and Smokeseals - Section 078413.

G. Joint Sealers - Section 079200.

1.4 SUBMITTALS

A. Submit Shop Drawings for the following:

1. Anchoring details.

2. Control and expansion joint locations and details.

3. Special brick shapes.

4. Flashing at typical lintels indicating relationship of flashing to lintel hangers.

5. Sills.

6. Decorative brickwork.

7. Weep locations.

8. Brick coursing layout.

B. Submit Samples for the following:

1. Each type of face brick in sufficient number and color (not less than 5) to show full range of color, texture and shade. Submit certification that brick meets ASTM standards specified herein.

a. Submit samples of all special shapes required showing color range and sizes.

2. Joint reinforcing, each type, width and proposed location (labeled).

3. Anchors, wedges and ties, each type, width and proposed location (labeled).

4. Joint filler, each type.

5. Flashing, including splice sample, 12" long.

6. Mortar color, 12" long cured sample.

C. Submit technical and installation information for the following:

1. Mortar materials, each material and mortar type.

2. Certification of mortar mix.

3. Flashing material, descriptive literature.

4. Concrete block, joint reinforcing, anchors, ties and joint filler; submit manufacturer's technical and descriptive literature.

5. Block manufacturer shall submit certifications of compliance with ASTM C 90, C 331 and UL 618 prior to any job site delivery. Field sampling of concrete block may be tested by an Independent Testing Laboratory retained by the Owner according to the requirements of ASTM C 140.

D. Cleaning Procedures: Submit proposed procedures and materials for cleaning masonry work; including certification that cleaner will not adversely affect stone, gaskets, sealants, etc.

1.5 QUALITY ASSURANCE

A. Conform to the following non-cumulative tolerances (any masonry work not meeting these standards shall be re-built as directed by the Architect).

1. Variation from the plumb:

a.	In lines and surfaces of columns, walls and arrises:	
1).	In 10 feet	1/8"
2).	In any story of 25 feet maximum	1/4"
3).	In 40 feet or more	1/4"
b.	For external corners, expansion joints and other conspicuous lines:	
1).	In any story of 25 feet maximum	1/4"
2).	In 40 feet or more	3/8"

2. Variation from the level or the grades indicated on the drawings; for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:

a.	In any bay or 20 feet maximum	1/4"
b.	In 40 feet or more	1/4"

3. Variation of the linear building lines from established position in plan related portion of columns and partitions:

a.	In any bay or 20 feet maximum	1/4"
b.	In 40 feet or more	1/2"

4. Variation in cross-sectional dimensions of columns and in thickness of walls:

a.	Minus	1/8"
b.	Plus	1/8"

5. Variation in dimensions of masonry openings:

a.	Horizontal dimension	-0" + 1/16"
b.	Vertical dimension	+0" - 1/16"

B. Job Mock-Up: Prior to installation of masonry work, erect sample wall panel mock-up using materials, bonding patterns and joint tooling required for final work and including cavity wall, masonry sill, window unit and sill, projecting courses, anchors and reinforcement as detailed. Provide special features as directed by the Architect for caulking and contiguous work. Build mock-up at the site, 4' x 4' size as directed by the Architect, indicating the proposed range of colors, textures and workmanship to be expected in the completed work. Reconstruct mock-up if directed by the Architect until it meets with Architect's approval. Obtain Architect's acceptance of visual qualities of the mock-up before start of masonry work. Retain mock-up during construction as a standard for judging completed masonry work. Do not alter, move or destroy mock-up until work is completed and accepted by the Architect. Use sample panels to test proposed cleaning procedures after sample panel meets with Architect's approval.

1. Approved sample panel shall remain on view at the site until completion of face brick work and shall establish the technical and aesthetic standards for the Project.

2. Architect shall direct distribution of brick color and texture variation within mock-up.

C. Factory Control

1. The Architect reserves the right to visit the brick manufacturer's facility and review pre-sorting so that all brick falls within a color range acceptable to the Architect.

2. Prior to any shipment of the face brick from the factory, the Architect reserves the right to inspect the brick for the thoroughness of the pre-sorting and to reject any brick that, in his opinion, does not fall within acceptable color range.

D. Work of this Section shall conform to the requirements of the following:

1. 2016 "Building Code Requirements for Masonry Structures," (TMS 402/602-16).

2. 2016 "Specification for Masonry Structures," (TMS 602-16).

3. Brick Industry Association (BIA) "Technical Notes on Brick Construction."

E. Pre-Construction Conference: Prior to installation of masonry and associated work, Contractor shall arrange a meeting with Masonry Subcontractor, installers of related work, and other entities concerned with masonry wall performance, including the Architect and Owner. Contractor shall record discussions and agreements and furnish copy to each participant. Provide at least seventy-two (72) hours' advance notice to participants prior to convening conference. Review methods and procedures related to masonry work, including, but not limited to, the following:

1. Review masonry requirements (drawings, specifications and other Contract Documents).

2. Review required submittals, both completed and yet to be completed.

3. Review and finalize construction schedule related to masonry work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.

4. Review required inspection, testing, certifying and material usage accounting procedures.

5. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.

6. Coordinate work with air/vapor barrier membrane and related flashing, review details to avoid conflicts.

1.6 PRODUCT HANDLING

A. General: Deliver, store, handle and protect all materials from damage, moisture, dirt and intrusion of foreign matter. Store all masonry units and mortar materials on raised platforms and under ventilated and waterproof cover. Store packaged materials in manufacturer's unopened containers, marked with manufacturer's name and product brand name. Immediately reseal containers after partial use. Remove and replace damaged materials.

B. Masonry Units: Pack, deliver and store to prevent breakage, cracking, chipping, spalling or other damage. Store, protect and ventilate units at project site.

C. Aggregate: Store with provisions for good drainage.

D. Reinforcement and Anchors: Store and protect so that when placed, joint reinforcement and anchors will be free of soil, dirt, ice, loose rust, scale, or other coatings which would destroy or reduce bond with mortar, and will not be disfigured or bent out of shape.

1.7 TESTING FOR EFFLORESCENCE

A. Test selected face brick for efflorescence in accordance with ASTM C 67.

B. If, at the end of the test period, the samples of brick or mortar show efflorescence, the materials represented shall be rejected and new materials shall be re-tested. This process shall be repeated until no efflorescence appears. Testing shall be done by an independent testing laboratory at the expense of the Contractor; submit test results in writing to the Architect.

1.8 JOB CONDITIONS

A. In cold weather, when the outside temperature is below forty (40) deg. F., conform to the requirements of "Cold Weather Masonry Construction and Protection Recommendations" publication by Brick Industry Association (BIA). No anti-freeze admixtures are permitted.

1. In addition, conform to the following:

a. Masonry materials must be warmed as required.
b. Brickwork must be protected a minimum of 24 hours after installation so as to maintain enough heat for hydration of the cement in the mortar.

B. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg. F. and above. In addition, conform to the following:

1. Masonry materials must be cool.

2. Mortar must be used within 2 hours of initial mixing.

C. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24" down both sides and hold cover securely in place.

2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24" down face next to unconstructed wythe and hold cover in place.

D. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt on completed masonry.

1.9 ATTIC STOCK

A. Provide additional 10% of dry mortar mix labeled, packaged and delivered to location determined by Owner for attic stock.

B. Provide additional 5% of brick labeled, packaged and delivered to location determined by Owner for attic stock.

PART 2 PRODUCTS

2.1 MATERIALS

A. Standard Concrete Block

1. Portland cement, ASTM C 150, Type 1, low alkali (less than 0.6%), single source for entire project.

2. Aggregates, ASTM C 331, lightweight expanded shale, clay or slate aggregates, manufactured by the rotary kiln process equal to "Solite," "Norlite," or "Haydite."

3. Concrete Masonry Units: Load bearing lightweight aggregate concrete masonry units conforming to the requirements of ASTM C 90, Type 1.

4. The producer of the concrete masonry units shall furnish certification from an independent testing laboratory confirming that all 8" or larger masonry units meet all of the UL 618 requirements for two (2) hours or better (as required), referencing full scale fire test reports (ASTM E 119).

5. Sizes and Shapes: Nominal face size 8" x 16" by thickness as indicated on drawings.

6. Finish: For exposed or painted block surfaces, in addition to ASTM requirements, block shall have uniformly dense, flat, fine grain texture, with no cracks, chips, spalls, or other defects which would impair appearance. For concealed CMU, surfaces shall be free from deleterious materials that would stain or corrode metal.

7. Curing: All concrete block shall be steam cured, and air dried for not less than thirty (30) days before delivery.

8. Density of concrete block shall not exceed one hundred and five (105) lbs. per cubic foot.

9. Shrinkage: Shrinkage of concrete blocks shall not exceed 0.065% when tested in accordance with ASTM C 426-16, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.

10. Water Content

a. At the time of delivery to the job site, concrete masonry units shall have a value, in weight of contained water, of not more than thirty (30) percent of the fully saturated content for the unit tested.
b. Ship all units from the factory, and store at the job site, with all necessary protection to prevent increase of water content from rain and other sources.

B. Brick

1. Manufacturer and Type: Greenleaf Brick, "Black Special."

2. Size: Unless otherwise indicated, provide 3-5/8" deep x 2-1/4" high x 11-5/8" long Norman bricks.

3. Facing Brick: ASTM C 216, Grade SW, Type FBX.

4. Where brick is fully concealed provide common brick conforming to ASTM C 62, Grade SW.

5. Provide all special molded shapes as indicated on the drawings.

a. Provide solid (uncored) bricks for rowlock sills.
b. Provide cut bricks at gabled roof.
c. Provide custom obtuse corner bricks that have finish on short and long ends.
d. Applied finish is standard on one stretcher and one header face.

6. For sills, caps and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncored units with all exposed surfaces finished.

C. Anchors and Ties

1. Approved Manufacturers

a. Hohmann & Barnard.
b. Wire-Bond.
c. Heckmann Building Products.
d. National Wire Products Industries, Inc.

2. For anchoring brick to cold-formed metal framing, provide the following or approved equal by other manufacturers noted above in Para. D.1:

a. Hohmann & Barnard Type 304 stainless steel HB-213-2X-SH with Optionlay washer and 345 345-BT with S.I.S. flexible tie.

3. Wire Mesh: Hot-dip galvanized sixteen (16) gauge steel wire, square mesh, width 3" by length to suit condition; No. 268 by Heckmann Building Products, or approved equal by manufacturer noted above in Para. D.1.

4. For anchoring masonry to structural steel, provide hot-dip galvanized steel, as listed, or approved equal by manufacturer noted above in Para. D.1:

    a. Made by Heckmann Building Products. Galvanizing shall conform to ASTM A 153, with zinc coating of 1.5 oz. of zinc per sq. ft.
        1). No. 195 Column Anchors
        2). No. 197 Column Anchors
        3). No. 315 Weld-On Anchor Rods with No. 316 Triangle Ties
        4). No. 315-B Weld-On Anchor Straps with No. 316 Triangle Ties
    b. Made by Hohmann & Barnard or approved equal. Galvanizing shall conform to ASTM A 153, with zinc coating of 1.5 oz. of zinc per sq. ft.
        1). No. 355 Column Anchors
        2). No. 356 Column Anchors
        3). No. 357 Beam Anchors
        4). No. 359 F anchor straps with VWT tie.

D. Reinforcing Bars and Rods: ASTM A 615, Grade 60. See Drawings for size.

E. Control and Expansion Joint Fillers

1. Vertical Installation Within Concrete Masonry Wall: Extruded high-grade neoprene rubber, cross shape, for use with concrete masonry sash units, which shall provide a force fit in the grooves of the sash block, and shall have 1/2" diameter tubular ends (compressed 25% when installed in 3/8" wide joint).

    a. Provide the following sizes:
        1). 2-5/8" wide control joint fillers for 4" block walls.
        2). 4-5/8" wide for 6" block walls.
        3). 6-5/8" wide for 8", 10" and 12" block walls.
    b. Provide backer rod and sealant joint over joint filler as per drawings and Section 079200 of these specifications.

2. Isolation Joint Filler at Abutting Construction and at Intersecting CMU Walls: Compressible and resilient closed cell neoprene gasket with pressure sensitive adhesive backing, thickness 30% greater than thickness of joint. Acceptable joint filler shall be "Everlastic, Type NN-1" by Williams Products, Inc., or approved equal. Recess joint filler and install backer rod and sealant as per drawings and Section 079200 of these specifications.

3. Within Face Brick: Provide filler rod and sealant installed by Section 079200. Filler depth shall be 2 times joint width.

    a. Compressible filler between top of brick and bottom of shelf angle shall be "Soft Joint Sealant" made by Polytite, or approved equal.

4. Within Expansion Joint at Face Brick: Manufacturer's standard preformed, pre-compressed, open-cell polyurethane foam sealant impregnated with a water based,

non-drying polymer modified acrylic water repellent. Provide "Seismic Colorseal" installed to twenty-five 25 percent compression, as manufactured by Emseal or approved equal.

a. Properties: Permanently elastic, mildew resistant, non-migratory, non-staining, and compatible with joint substrates and other joint sealants. Density: 8.4 to 9.1 lb./cu. ft.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type 1, standard color, one source.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: Clean, washed, buff colored sand, graded per ASTM C 144.

D. Aggregate for Grout: ASTM C 404.

E. Water: Clean, fresh and suitable for drinking.

F. Refractory Mortar Mix: For firebox brick and clay flue liners, provide ground fireclay or non-water soluble, calcium aluminate, medium duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.

2.3 MORTAR MIX

A. Exterior Face Brick Construction: Mortar mixes shall meet ASTM C 270, Type N, cement/lime mortar. Colors of mortars shall use coloring agent made by Davis Colors, Lehigh Cement or approved equal. Color of mortar to meet with Architect's approval. The Contractor may use pre-packaged colored mortar equal to "Color Mortar Blend" made by Glen-Gery.

1. Color of mortar must meet with Architect’s approved sample and mock-up panel.

B. Exterior Block Construction: Provide Portland cement/lime mortar as noted above conforming to ASTM C 270, Type N.

C. Reinforced Concrete Block: Provide Portland cement/lime mortar conforming to ASTM C 270, Type S.

D. Grout for Unit Masonry: Comply with ASTM C 476 for grout for use in construction of unit masonry. Use grout of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout. Grout shall have a minimum compressive strength of 3000 psi when tested in accordance with ASTM C 1019.

E. Mixing

1. General: Add cement just before mixing and mix dry. Use sufficient amount of water as necessary to produce workable mix. Mix in small batches to make plastic mass.

2. Mixing: Machine mix all mortars in approved type mixer with device to accurately and uniformly control water. Add hydrated lime dry. Mix dry materials not less than two (2) minutes. Add water, then mix not less than three (3) minutes, not to exceed five (5) minutes. Mix only amount of mortar that can be used before initial set. Do not use mortar which has reached its initial set or two (2) hours after initial mixing, whichever comes earlier. Mortar may not be re-tempered. Clean mixer for each batch, whenever mortar type is changed, and at end of each day's work.

3. Acceleration or other admixtures not permitted.

4. Mortar shall have a flow after suction of not less than seventy-five (75) percent of that immediately after mixing as determined by ASTM C 91.

F. Admixtures

1. No air-entraining admixtures or cementitious materials containing air-entraining admixtures shall be used in the mortar.

2. No antifreeze compounds or other substances shall be used in the mortar to lower the freezing point.

3. Calcium chloride or admixtures containing calcium chloride shall not be used in mortar.

2.4 MASONRY ACCESSORIES

A. Weep Holes: Provide clear plastic weep holes 3/8" wide and 1-1/2" high by four (4) inches long equal to No. 342 made by Hohmann & Barnard or approved equal manufacturer listed above.

B. Through-Wall Flashing: Provide sheet membrane flashing as part of exterior wall membrane system. Provide sealants and tapes as recommended by the manufacturer. Provide preformed corner sections "end dams" with system when flashing is discontinuous.

1. Provide flashing for surface adhered applications at sheathed areas with 26 ga. stainless steel termination bar.

2. Wall flashing shall have 26 ga. stainless steel drip edge adhered to edge of flashing, drip edge shall be set in sealant as specified in Section 079200.

C. Cavity Drainage Material: Provide 10" high HDPE "Mortar Net" open mesh mortar net of width to fit masonry cavity shown on drawings, manufactured by Mortar Net USA, Ltd., or equal "Mortar Maze," made by Advanced Building Products.

2.5 POLYMER-MODIFIED MASONRY WATERPROOFING

A. Provide manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with polymer admixture to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists negative-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.

B. Product (Basis of Design): Subject to compliance with requirements, provide "Drylok" powdered masonry waterproofer as manufactured by United Gilsonite Laboratories, or approved equal.

1. Water Permeability: Maximum zero for water at 30 feet when tested according to COE CRD-C 48.

2. Compressive Strength: Minimum 4000 psi at 28 days when tested according to ASTM C 109.

3. Flexural Strength: Minimum 710 psi at 28 days when tested according to ASTM C 348.

4. Bond Strength: Minimum 220 psi at 14 days when tested according to ASTM C 321.

5. Color: Match Architect's samples.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection: Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

1. Verify that masonry may be completed in accordance with all pertinent codes and regulations, the referenced standards, and the original design.

2. Do not start any work until mock-ups are approved by the Architect.

B. Discrepancies: In the event of discrepancy, immediately notify the Architect in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved. Starting of work by the Contractor means acceptance by the Contractor of the substrate.

3.2 COORDINATION

A. Carefully coordinate with all other trades to ensure proper and adequate interface of the work of other trades with the work of this Section.

3.3 PREPARATION

A. Brick

1. Wet brick having an initial rate of absorption greater than 30 grams per 30 square inches when tested per ASTM C 67. Wet bricks by allowing water to run on the cubes or pallets of brick, or placing them in a large tank of water.

2. Except for absorbent units specified to be wetted, lay masonry units dry.

B. Concrete Block: Do not wet concrete block units.

3.4 INSTALLATION

A. General

1. Build walls to the full thickness shown. Build single wythe walls to the actual thickness of the masonry units, using units of nominal thickness shown.

2. Build chases and recesses as shown or required for the work of other trades.

3. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

4. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to properly locate openings, movement type joints, returns and off-sets. Avoid the use of less than half size units at corners, jambs and wherever possible.

5. Lay up walls plumb and true with courses level, accurately spaced and coordinated with other work.

6. Provide templates made of steel studs for plumbing of two-story masonry openings.

7. Pattern Bond: Lay exposed masonry patterns as noted on drawings. If not shown, provide running bond. Lay concealed concrete block with all units in a wythe bonded by lapping not less than two (2) inches. Bond and interlock each course of each wythe at corners. Do not use units of less than four (4) inches horizontal face dimensions at corners or jambs.

8. Where possible, masonry walls and partitions shall be built after all overhead ducts, pipes and conduits are in place and tested. Masonry shall be neatly built around the items above. Walls and partitions shall be plumb, true to line and free from defects such as open cells, voids, dry joints and other similar defects. In rooms and spaces scheduled to have concrete block finish, all such surfaces including upper wall surfaces up to termination of structural ceiling in spaces without suspended ceilings, shall be made suitable for paint application. Cutting of openings in walls and partitions in place shall be done only with the approval of the Architect.

9. Do not use any brick that do not meet chippage and tolerances of the applicable ASTM standard noted herein for the grade, type or class of brick.

10. Mortar, ties and reinforcement must not extend into or bridge any expansion joints.

B. Mortar Bedding and Jointing

1. All joints between bricks shall be completely filled with mortar. Bed joints shall be beveled per BMI recommendations, with the brick then shoved in place. At cavity wall construction, care shall be taken that no excess mortar goes into masonry cavity. Head joints shall be completely filled with mortar and shall be formed by applying a full coat of mortar to the entire end or the entire side, as the case requires, and then shoving the mortar covered end and/or side of the brick tightly against the bricks previously laid; the practice of “slushing” by throwing mortar into the head joints will not be permitted. All brick shall be laid without disturbing the brick previously laid. Brick shall be laid within a minute or so after the mortar is placed. Dry or butt joints will not be permitted. Grouting shall be done only as necessary. Do not slush head joints.

2. After brick placement, mortar squeezed out of bed joints shall be cut off before tooling.

3. Lay concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on exterior walls and in all courses of piers, columns and pilasters, where solid CMU is used and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.

4. Lay masonry walls with 3/8" joints unless otherwise shown on drawings.

5. Tool exposed joints slightly concave after the mortar joint is thumbprint hard. Concealed joints shall be struck flush. Tool joints as detailed on the drawings.

6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

C. Stopping and Resuming Work: Rake back 1/2 brick length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

D. Built-In Work

1. As the work progresses, build in items specified under this and other Sections of these specifications. Fill in solidly with masonry around built-in items.

2. Mortar in door frames, access doors, louvers and other metal items embedded or built into masonry work solidly with mortar as the masonry units are laid up.

3. Grout under lintels, bearing plates, and steel bearing on masonry with solid bed grout.

4. Sleeves, pipes, ducts and all other items which pass through masonry walls shall be caulked with interior grade sealant meeting requirements of Section 079200, so as to be airtight and prevent air leakage. Refer to Section 078413 for packing of voids in rated masonry walls.

5. Unless otherwise noted, fill vertical cells of masonry units solid with grout which are below steel bearing plates, steel beams, and ends of lintels, to eight (8) inches beyond bearing and from floor to bearing.

6. Place wire mesh in horizontal joint below masonry unit cells to be filled with mortar, to prevent mortar from dropping into unfilled cells below.

7. Masonry indicated as being reinforced shall have all voids filled solid with grout. Grout shall be consolidated in place by vibration or other methods which insure complete filling of cells. When the least clear dimension of the grouted cell is less than two (2) inches, the maximum height of grout pour shall not exceed twelve (12) inches. When the least clear dimension is two (2) inches or more, maximum height of grout pour shall not exceed forty-eight (48) inches. When grouting is stopped for one (1) hour or longer, the grout pour shall be stopped 1-1/2" below the top of a masonry unit. Vertical bar reinforcing shall be accurately placed and held in position while being grouted, and shall be in place before grouting starts. All such reinforcing shall have a minimum clear cover of 5/8". Lap all bars a minimum of forty (40) bar diameters and provide steel spacer ties (not to exceed 192 bar diameter) to secure and position all vertical steel and prevent displacement during grouting. Provide continuous horizontal reinforcement embedded in mortar joints every second course.

E. Cutting and Patching

1. All exposed masonry requiring cutting or fitting shall be cut accurately to size with motorized carborundum or diamond saw, producing cut edges.

2. Do not saw cut any masonry openings in face brick construction without Architect's approval and after a procedure has been reviewed and approved.

3. Holes made in exposed masonry units for attachment of handrail brackets and similar items shall be neatly drilled to proper size.

4. All masonry which requires patching in exposed work, if approved by Architect, shall be patched neatly with mortar to match appearance of masonry as closely as possible and to the Architect's satisfaction. Rake back joints and use pointing mortar to match as required.

F. Cavity Walls

1. Cavities shall be kept clean and clear of all mortar droppings, and no mortar ledges shall project into the cavity. Temporary wood strips, cut to width of cavity and fitted with lift-up wires, shall be laid on the joint reinforcement and carefully lifted out before placement of the next layer of reinforcement. Any projecting mortar shall be spread over the back of the outer wythe immediately following the setting of the masonry unit.

    a. Cavity drainage material shall be installed at the bottom of each cavity over the flashing to protect weep holes.

2. Refer to Section 072100, "Thermal Insulation," for material and installation of cavity wall insulation.

G. Ties and Anchors for Masonry Construction

1. Provide ties and anchors as shown or specified, but not less than one metal tie, spaced not to exceed sixteen (16) inches o.c. horizontally and/or vertically. Provide additional ties within 1'-0" of all openings and adjacent to expansion joints and spaced not more than 16" apart around perimeter of openings.

2. Anchoring Masonry to Structure: Provide an open space not less than 1/2" in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar or other rigid materials.

3. Attach brick veneer to cold-formed metal framing by anchoring brick to studs using specified anchors penetrating through sheathing and through flange of stud. Prior to application of anchors cover sheathing and vapor barrier with tape specified herein. Space anchors 8" o.c. at each stud; provide stainless steel screw anchors for attaching anchor to studs.

H. Control and Expansion Joints

1. Provide expansion, control and isolation joints in masonry as shown. Build in related items as the masonry work progresses.

2. CMU Control Joint Spacing: If location of control joints is not shown, place vertical joints spaced not to exceed 40'-0" o.c. In addition, locate joints at points of natural weakness in the masonry work, including the following:

    a. At structural column or joint between bay.
    b. Above control joints in the supporting structure.
    c. Above major openings at end of lintels upward and below at ends of sills downward. Place at one side of jamb for openings not less than 6'-0" wide and at both sides for openings over 6'-0" wide.
    d. At reduction of wall thickness.
    e. Where masonry abuts supporting structure.

f. If additional joints are required, indicate same on approved shop drawings.

3. Brick Veneer Expansion Joint Spacing: Vertical expansion joints in brick veneer construction shall be located maximum 20'-0" o.c. unless otherwise noted in addition to expansion joints located within 2'-0" of each corner of the building.

I. Lintels: Install loose steel lintels furnished by Section 055000, allowing eight (8) inch bearing at ends.

3.5 FLASHING/WEEP HOLES

A. General: Install embedded flashing and weep holes in masonry at relieving angles, shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated. Space weeps 16" o.c. unless otherwise shown on drawings.

B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing.

C. Flashing shall be placed, generally, at bottoms of cavity wall construction, over all wall openings, window jambs, at sills of window, and in other locations where indicated on the drawings. Flashing shall overlap a minimum of 6". At sheathed areas, flashing shall be attached with a pressure bar. Extreme care shall be exercised in placing the masonry materials not to damage the flashing. Flashing damaged during the masonry erection shall be repaired or replaced by the Contractor at no additional cost to the Owner. Discontinuous flashing shall terminate with an end dam in a head joint, rising at least 1".

D. When spanning an air space, flashing shall be supported with a mortar wash, insulation or treated wood blocking.

E. Where flashing is penetrated by anchors, patch flashings at penetration using adhesive and mastic recommended by the manufacturer to insure watertight seal.

F. Install flashing in accordance with manufacturer's instructions, using adhesive, primer, thinner, cleaner and mastic as recommended by flashing manufacturer.

1. Flashing shall overlap adjacent piece of flashing a minimum of 6".

G. Provide drip edge when flashing extends beyond face of brick.

3.6 CLEANING, PROTECTION, ADJUSTMENT

A. Protection

1. The Contractor shall take adequate precautions for the protection of all surfaces against mortar spatter and shall immediately remove any such spatter should it inadvertently occur, leaving no stain or discoloration.

2. Excess mortar shall be wiped off the masonry surfaces as the work progresses.

3. Wood coverings shall be placed over all such masonry surfaces as are likely to be damaged during the progress of the entire project.

4. Protective measures shall be performed in a manner satisfactory to the Architect.

5. Damaged masonry units shall be replaced to satisfaction of the Architect.

6. Exterior masonry walls shall be draped with waterproof covering until copings are in place, to prevent water penetration in cavity.

B. Cleaning of Masonry: Upon completion, all exposed masonry shall be thoroughly cleaned following recommendations of the BIA Technical Note No. 20. Before applying any cleaning agent to the entire wall, it shall be applied to a sample wall area of approximately 4' x 4' in a location approved by the Architect. No further cleaning work may proceed until the sample area has been approved by the Architect, after which time the same cleaning materials and method shall be used on the remaining wall area. If stiff brushes and water do not suffice, the surface shall be thoroughly saturated with clear water and then scrubbed with a solution of an approved detergent masonry cleaner, equal to "Vana Trol" made by ProSoCo Inc. or equal made by Diedrich or approved equal, mixed as per manufacturer's directions, followed immediately by a thorough rinsing with clear water. All lintels and other corrodible parts shall be thoroughly protected during cleaning.

1. Unless otherwise required by cleaning agent manufacturer use only low-pressure device (30 to 50 psi) for application of cleaning agent and water rinsing.

C. Pointing: Point any defective joint with mortar identical with that specified for that joint.

END OF SECTION

SECTION 044200

EXTERIOR STONE CLADDING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the exterior stone cladding as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Exterior stone facing panels, fascias, special shapes, piecework, and all other stone elements for exterior stone walls.

2. Furnishing, cutting, fabricating, delivery, and setting of all stonework.

3. Anchors, dowels, cramps, bolts, nuts, threaded studs, expansion shields, inserts, loose clips, loose angles, struts, relieving angles, support angles, shims, steel frame supports, wire anchors, tape, and all other fastening devices and accessories necessary for complete setting and anchorage of stone wall facings to masonry and concrete back-up.

4. Protection of stone during transit, storage, erection, and installation. Cleaning of stone prior to acceptance.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Sheet Metal Flashing - Section 076200.

C. Sealing of stone-to-stone joints - Section 079200.

D. Interior Stone Cladding - Section 097500.

1.4 DOCUMENTATION

A. The drawings (floor plans and design details) and specifications are an outline of the criteria and performance requirements of the work. The requirements shown by the details are intended to establish basic dimensions of the module and the sight lines and profiles of members. Within these parameters, the Contractor is responsible for the design and engineering of the system, including whatever modifications or additions may be required to meet the specified requirements and maintain the visual design concept for the entire work of this Section.

B. It is recognized that the design details do not cover every condition. It is, however, intended that any conditions not detailed shall be developed through the Contractor's shop drawings to the same level of aesthetics, and in compliance with performance criteria, as indicated for detailed areas and stipulated in these specifications. The Contractor, by accepting a contract for the work, acknowledges this and agrees that the Architect shall have the final say as to all matters whether detailed or not on the design drawings.

1.5 QUALITY ASSURANCE

A. The work of this Section shall be performed by Subcontractors who are regularly engaged in the engineering, manufacture, fabrication, finishing, installation, and sealing of similar work. Each subcontractor shall demonstrate to satisfaction of the Architect that he has successfully performed on comparable projects over the previous five years. All fabricating shall be done in Subcontractor's own plant. Further subcontracting of any work included hereunder is specifically prohibited, except for that which may be approved by the Architect in writing prior to award of this contract.

B. The Architect reserves the right to visit the fabricating facilities of the Subcontractor at any time when the work is in progress. All shop and field materials and workmanship shall be subject to inspection by the Architect and his representatives at all times. Such inspections do not relieve the Contractor from obligations to provide materials conforming to all requirements of the Contract Documents.

C. The Contractor, by commencing the work of this Section, assumes overall responsibility, as part of his warranty of the work, to assure that all assemblies, components and parts shown or required within the work of this Section, comply with the Contract Documents. The Contractor shall further warrant:

1. That all components, specified or required to satisfactorily complete the installation, are compatible with each other and with the conditions of installation and expected use.

2. The overall effective integration and correctness of individual parts and the whole of the system.

3. Compatibility with adjoining substrates, materials and work of other trades.

4. There shall be no premature material failure due to improper design and fabrication of the stone. All materials are to fully perform to their normal life expectancy.

5. Each piece of stone shall be subject to the Architect's approval, and any piece or pieces which may be rejected after having been set shall be carefully cut out and replaced with new suitable stone without delay, and without cost to the Owner. Any piece or pieces damaged in the removal and resetting of defective pieces shall also be removed, and suitable, approved pieces provided and set.

D. Architect's inspection of the stone does not relieve the Contractor from his responsibility to provide all stonework in accordance with the approved samples and shop drawings.

E. Examination Criteria: All examinations, selections and approvals shall be for the purpose of achieving a final appearance of stone with the greatest possible uniformity, and will be based upon the following criteria:

1. Color within approved, pre-selected color ranges and finish.

2. Sequence matching of adjacent stone units, as approved by the Architect.

3. Only one source of each type of stone shall be used throughout the work. Stone shall match the type, pattern, color, texture and finish of samples available for inspection in the office of the Architect.

4. Conformance to approved shop drawings and details within specified dimensions and tolerances.

5. Other criteria as specified in Part 2 - Products, herein.

1.6 SUBMITTALS

A. Shop Drawings: Prior to construction of mock-up, submit shop drawings for the fabrication and installation of all work and associated components. Include:

1. Wall elevations at 1/4" scale, typical unit elevation at 1" scale.

2. Show details of all conditions for every member, joint, anchorage and provision for expansion and contraction and joint treatment.

3. Include coordination details for related and adjoining work, insert drawings and erection diagrams. Show relative layout for all adjacent walls, beams, columns and slabs, all correctly dimensioned.

4. Stone: Submit complete cutting and setting drawings to Architect for approval. Shop sizes, shapes, thicknesses, jointing, anchoring, connection with other work, typical and special anchoring details, supports, dimensions, setting numbers, and color range for each piece of stone. Clearly indicate dimensions for locating slots in stone and for locating inserts to be built into concrete and masonry. Do not fabricate any stone (except for samples) until shop drawings have been approved by the Architect. Shop drawings shall be based upon actual field measurements to determine exact dimension of each stone piece and anchorage required. Dimensions shown on shop drawings shall be actual field dimensions.

B. Provide structural calculations, prepared by a Professional Engineer licensed in New York, prepared in compliance with referenced documents and these specifications. Where specifications and code differ, the more stringent requirement shall govern. Calculations shall be legible and shall incorporate sufficient cross references to shop drawings to make the calculations readily understandable and reviewable. Calculations shall include the following information:

1. Analysis for all applicable loads on substrate.

2. Analysis for all applicable loads on anchors.

3. Analysis of stress in stone and required safety factors.

C. Allowable stresses for stone shall be based upon material properties required herewith and computed as follows:

Coefficient of Variation (Standard Deviation/Mean)	Modulus of Rupture	Safety Factor Required
0-5 percent	Mean	2.0
5-10 percent	Mean	2.5
10-15 percent	Mean	3.75
15-20 percent	Mean	5.0

D. Safety factors required at anchor locations shall be 2.0 times the values noted above for the allowable stresses in the field of the panel.

E. Calculation of allowable stresses on stone shall be based upon the minimum thickness (nominal thickness minus the thickness tolerance). Under no condition shall stone thickness be less than that indicated on the Drawings.

F. Review of calculations and shop drawings by the Architect will not relieve the Contractor of any responsibilities for providing a system within the required performance requirements. Calculations shall be signed and sealed by the Contractor's Engineer.

G. Manufacturer's Data

1. Submit copies of manufacturer's specifications and installation instructions for each stonework accessory required. Include data substantiating that materials comply with specified requirements. Indicate that installer has received copy of manufacturer's instructions.

2. Manufacturer's instructions for handling and storage at job site; installation and protection of stone. Indicate that erector of stonework has received a copy of each instruction.

H. Samples

1. Submit samples of all materials and finishes and details. Samples include standard submission samples, pictures of slabs, stoneyard slab review, and additional samples as described below.

2. Samples shall demonstrate the complete range of visual properties of the material and finish as specified in PART 2 – MATERIALS.

3. Samples shall represent the single exposed surface grain, i.e. head, rift or lift, as proposed by the Contractor and approved by the Architect.

4. Sample slabs shall be displayed at the quarry or the fabrication plant as selected by the Architect.

5. First Submission Sample Slabs: The first submission shall be taken from representative areas (e.g. top, middle or bottom) of each existing or proposed quarry work station required to provide Dimension Stone, and are to represent the proposed range of visual properties, including color, value (lightness/darkness), figuring, grain direction, dark inclusions, etc. Sample slabs shall be the full dimensions of the quarried blocks and finished as specified in PART 2 – MATERIALS.

6. Subsequent to the Architect's approval of the First Submission Sample Slabs, one identical set of control samples of the approved range shall be submitted for approval and provided to each of the following: the Owner, the Architect, and the General Contractor. The fabricator shall maintain an original sample set until completion of the Project.

7. Samples shall be the following sizes:

    a. Initial sample, pictures of slabs, stone yard slab review. 5 samples from 10 different blocks.
    b. Standard Submission Samples: 12 inches x 12 inches.
    c. Sample Slabs: Sample slabs shall be full quarried block dimension, job thickness, as described above.

8. Additional Samples: The Contractor for the Work of this Section shall have available an adequate quantity of matching approved samples as in Item a. above, to be provided in order to enable the Architect to coordinate the construction and finishes of other trades.

1.7 FABRICATION AND ERECTION TOLERANCES

A. Tolerances are as follows:

1. Except as noted, all joints shall be 3/8".

2. Stone dimension tolerance shall be +0, -1/16" in both directions with 90 deg. angle for all corners.

3. Stone face dimension tolerance (flatness) shall be +0, -1/16" in all directions.

4. Stone thickness tolerance shall be -1/4", +1/4".

B. Variation From Plumb: For lines and surfaces of walls and arrises, do not exceed 1/8" in 20 ft. max. For external corners, expansion joints and other conspicuous lines, do not exceed 1/8" in any story or 20 ft. max.

C. Variation of Linear Building Line: For position shown in plan and related portion of grid lines, walls and partitions, do not exceed 1/8" in any bay or 30 ft. max.

D. Offset at Joints: Do not exceed plus or minus 1/32".

E. Slope, Splay, and Miter Cuts: Plus or minus 1.5 degrees.

F. Square Cuts: Plus or minus 1/16" per 3'-0".

1.8 PERFORMANCE REQUIREMENTS

A. Structural Requirements: The work, as erected, shall be designed to withstand a lateral force of 30 psf (or greater if required by Code) applied over field surface normal to face of stone. Deflection under this load shall be limited to L/360 or 3/8" whichever is less.

B. Provision for Thermal Movements

1. The work shall be designed to provide for such expansion and contraction of component material, as will be caused by a surface temperature ranging from -20 deg. F. to +180 deg. F., without causing buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance or other detrimental effects.

2. The amount of such movement that is accommodated in the Contractor's design and method of accommodating it shall be identified on Contractor's submittal drawings, and shall be accompanied by thermal calculations.

C. Provision for Movement of the Structure

1. The work will be designed to accommodate dead load and live load bending deflection and column shortening as follows:

   a. Anticipated interstory differential vertical movement
      Slab Deflection:
      Column shortening:
   b. Anticipated interstory differential lateral movement:
   c. All values are maximum values and include long term creep effects.

2. The above movements are net structural frame motions and not joint sizes

3. The amount of such movement that is accommodated in the Contractor's design shall be identified on the Contractor's submittal drawings.

D. Methods and fabrication and assembly (except as specified herein) shall be at the discretion of the Contractor provided that the visible architectural effect is not changed, the work of other Contractors is not affected and the strength qualities, as demonstrated by engineering calculations are not reduced.

E. Remedial measures, which may be necessary on the building, shall maintain standards of quality and durability and are subject to approval by the Architect.

F. Anchors: Adequate number and size of anchors shall be provided to satisfy the load requirements and design criteria.

G. Variations in Structure: The work shall be designed to accommodate variation in location of surrounding and supporting work, as defined as allowable variations in the work, as specified in other Sections of the project Specifications.

1.9 CODES AND STANDARDS

A. All work shall be performed in accordance with the prevailing Building Code, or the requirements of this Specification, whichever are more stringent.

B. Stone Cladding System shall conform to, but not be limited to, the following codes and standards:

1. National Building Granite Quarries Assoc. (NBGQA).

2. American National Standards Institute (ANSI).

3. Marble Institute of America (MIA) "Dimension Stone Design Manual," latest edition.

4. Building Stone Institute (BSI).

5. American Society for Testing and Materials (ASTM).

1.10 STONE TESTING

A. The Contractor shall execute a comprehensive testing program to identify the material properties and ensure that acceptable properties are maintained throughout production.

B. Material Properties

1. The following material properties shall be identified for the stone:

	Material Property	Test Method	Test Samples
a.	Absorption and Bulk Specific Gravity	ASTM C 97	5
b.	Modulus of Rupture	ASTM C 99	20
c.	Modulus of Rupture (modified for job thickness and finish)	ASTM C 99	20
d.	Compressive Strength	ASTM C 170	20
e.	Flexural Strength	ASTM C 880	20
f.	Modulus of Elasticity (performed concurrently with C 880)	ASTM C 580	20
g.	Petrology	ASTM C 295	

2. Product Testing

a. Provide a testing program for modulus of rupture/flexural strength during production. The Contractor shall propose a program indicating frequency of testing for approval by the Architects after selection of the stone is finalized.

b. Testing program shall consist of two parts:
   1). Testing to confirm material properties of the production stone.
   2). Intermittent testing during production to confirm material properties.
   3). Modulus of rupture/flexural strength shall be tested for the worst case loading condition.

4). Testing should be to the following standard:

		Test Method	Samples Tested
(a).	Flexural Strength (modified for thickness and span)	ASTM C 880/580	20 for first test, 5 thereafter.
(b).	Modulus of Rupture (modified for thickness and finish)	ASTM C 99	20 for first test, 5 thereafter.

5). Material properties shall be derived from testing conducted by an independent certified testing laboratory. Properties reports shall indicate the laboratory name, address, date of testing, method of testing and the description and number of test specimens for each property tested.

6). Strength properties shall be indicated for each specimen tested, and expressed as a mean with standard deviation and coefficient of variation for each condition tested.

3. Adhesively-Bonded Stone

a. The Contractor shall propose a comprehensive testing program for epoxy-mitered corners for approval by the Architect. The testing program shall include pull-out tests for shear, tension, and shear and tension combined. Test specimens shall be subjected to a series of cycles of wet and dry conditioning after epoxy adhesion and before testing for failure.

b. A minimum of five (5) full-size specimens shall be tested.

4. Stone Anchors

a. For each type of stone anchor, a series of tests shall be performed including:
   1). Shear.
   2). Tension.
   3). Shear and tension combined.

b. Anchors shall be tested to destruction.

c. A minimum of 5 specimens of each anchor type shall be tested.

d. Submit test method for approval by the Architect.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect stone during storage and construction against moisture, soiling, staining, and physical damage.

B. Handle stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials. Lift with wide-belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides.

C. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with

waterproof, non-staining covers or enclosures, but allow air to circulate around stone.

D. Protect mortar materials and stonework accessories from weather, moisture, and contamination with foreign materials.

1.12 JOB CONDITIONS

A. Installer must review installation procedures and coordination with other work with Contractor and other subcontractors whose work will be affected by stonework.

1.13 PROTECTION

A. Protect adjacent surfaces from damage. Protect exposed surfaces of stone units from damage or defacement. Prevent materials used for installing work of this Section from staining or damaging the exposed surfaces of stone units or the exposed surfaces of the adjoining construction.

B. Protect all stonework from other materials that will cause staining or defacement. Stone subject to damage after setting shall be properly covered or protected.

C. No lumber or other material liable to stain or deface the stone shall be used.

1.14 GUARANTEE

A. Unless stated otherwise in these Specifications, guarantee shall state that all work is in accord with drawings and Specifications, as amended by any changes thereto authorized by the Architect, free from defects in materials and workmanship for a period of five (5) years from date of acceptance of the work by the Owner or failure of system to meet performance requirements. Contractor shall agree to repair or replace defective materials and workmanship during the guarantee period at no additional cost to the Owner.

B. Defective materials and workmanship are hereby defined to include evidence of abnormal deterioration, aging, structural failure of components resulting from exposure to normal load and forces, failure of operating parts to function normally, sealant failures, deterioration or discoloration of finishes in excess of normal aging, and failure to fulfill other specified performance.

C. Contractor and respective subcontractors shall be responsible for damage to the building and furnishings occasioned by defective materials or workmanship or damage as part of repairs to the stone cladding.

D. The guarantee, the enforcement or lack of enforcement thereof, shall not deprive the Owner of other actions, rights or remedies available to him. Guarantee shall be in form approved by the Architect.

PART 2 PRODUCTS

2.1 STONE

A. Stone shall be as indicated on the Materials List.

B. Finish: Stone shall have a honed finish on all exposed surfaces; concealed surfaces may be sawn. Edges to receive grout or sealant shall be sawn.

C. Quarrying Supervision

1. Quarrying shall be supervised and coordinated by the stone fabricator to insure that the as-quarried block orientations will yield finished material with characteristics as described herein.

2. All stone shall be cut from matched blocks. Matched blocks shall mean blocks extracted from a single bed of stratum in the quarry. The use of blocks chosen at random, though similar in general character and color to that of the approved stone shall not be permitted, except by written permission of the Architect.

D. Examinations

1. Examination at the Quarry: Quarried blocks shall be made available for inspection by the Architect at his request.

2. Examination at the Fabrication Plant: Production units shall be made available for inspection by the Architect at his request. To this end, the Contractor shall, after approval of final shop drawings, advise the Architect when production has begun and of the earliest possible opportunity to inspect a representative sampling of production work.

3. Contractor shall provide lighting that is sufficient in intensity and color range to permit an adequate examination to the satisfaction of the Architect.

E. Visual Criteria for Stone: All examinations, selections, and approvals shall be for the purpose of achieving a final appearance of stone with greatest possible uniformity, and will be based upon the following criteria:

1. All stone shall be of sound stock and uniform texture, and shall be free from holes, seams, shakes, clay pockets, spalls, stains, starts, and other defects which would impair the strength, durability, and appearance of the work, as determined by the Architect.

2. Inherent variations characteristic of the stone and the quarry from which the stone is to be obtained shall be brought to the attention of the Architect at the time the samples are submitted for approval, and shall be subject to approval of the Architect.

3. All stone shall be selected for background color, veining, marking and matching, shall run in even shades, and shall be set accordingly.

2.2 ACCESSORY MATERIALS FOR STONEWORK

A. Mortar Materials

1. White Portland Cement: ASTM C 150, Type 1, non-staining. Cement shall in no case contain more than 0.03% by weight of soluble alkali (calculated as Na_2O). Submit mill certificates of cement and certified analysis from an approved testing laboratory.

2. Sand: ASTM C 144, except graded with 100% passing No. 16 sieve, non-staining.

3. Hydrated Lime: ASTM C 207, Type S.

4. Water: Potable, clear and free of deleterious materials which would impair the quality of the mortar.

5. For colored pointing mortar, provide integral, non-fading colorant made by Davis Colors or approved equal; color selected by the Architect.

B. Stone Support

1. Manufacturer and General: Stone support systems, anchors and accessories shall be manufactured by a company specializing in the design and fabrication of stone approved by the Architect. Provide all fastening devices, wire anchors, support angles, relieving angles, anchors, coping anchors, dowels, cramps, bolts, nuts, shims, expansion shields, flashing, etc., necessary to properly secure stone walls to the structure.

2. Stainless Steel to be used for stone supports shall conform to the following:

   a. Sheet, Bar and Plate: AISI Type 302/304 non-magnetic, conforming to ASTM A 167.
   b. Fasteners, Anchor Bolts, Nuts and Washers: AISI Type 302/304 non-magnetic, ASTM A 167.
   c. Shims: AISI type 302/304, non-magnetic.

C. Setting Pads: Lead or plastic.

D. Weeps: No. 341 plastic weep tubes, 1/4" O.D. made by Hohmann & Barnard or approved equal.

E. Flashing: 26 ga. ASTM A 666, Type 304 stainless steel.

2.3 FABRICATION

A. All stone work shall be executed by mechanics skilled in the trade. All stone shall be well cured and seasoned before cutting. Cut stone units with bed, unless otherwise approved by the Architect.

B. Stone shall be accurately cut to sizes, shapes, profiles and dimensions. There shall be no deviation from jointing.

C. Exposed surfaces and edges of stone units shall be free from cracks, broken corners, chipped arrises, scratches or other defects affecting appearance. Patching or filling not permitted. Edges of stone panels are to be finished.

D. Backs of stone units shall be sawn to true planes, parallel to face plane.

E. Cut stone units full and true on faces, reveals, beds, joint and top, to the full dimensions required by drawings. All edges shall be straight and true with sharp and true arrises. All stone shall fit together accurately.

F. Make faces of stone units in same plane flush at joints. All finished surfaces shall be true in line and face.

G. Sawn surfaces and edges shall be cleaned of all rust stains and iron particles.

H. No patching or use of stone with chipped edges or faces shall be permitted.

I. Thickness: Provide stone panel of thickness shown on drawings. Saw-cut back surfaces which will be concealed in the finished work. Provide greater stone thickness than shown where thickness shown is insufficient for the sizes or where extent of cut-outs shown decreases effective strength of the remaining material, or for proper and sufficient anchorage, suitable and adequate bearing areas for surfaces.

J. Adhesively Bonded Units

1. Adhesive shall be a 2neutral non-oil-based cure silicone designed specifically for structural bonding of stone units.

2. Prepare stone, mix adhesive, and fabricate bonded units in accordance with the recommendations of the NBGQA and adhesive manufacturer's instructions. Color shall match stone.

3. Adhesively bonded units shall be fabricated with a non-continuous stone liner reinforcing that is mechanically secured to both face stones and stainless steel dowels. Size and spacing shall be designed to achieve a mechanical support should the adhesive fail.

4. Finish joints shall be smooth and without staining or excess adhesive on exposed surfaces. Remove adhesive from exposed joints after hardening and leave finish surfaces without damage, or impairment of the polished finish.

2.4 CUTTING, DRILLING AND FITTING

A. Provide holes and sinkages required for anchors, dowels, other devices required to support and/or suspend stone, and to accommodate other items which connect to or penetrate the stone.

B. Include all cutting, drilling and fitting of stone work required to accommodate the work of other trades. In cutting and fitting, carefully cut and grind edges to a neat tight fit. Do cutting in such manner so as not to impair strength or

appearance of stone. Use physical templates for all cutting and drilling; obtain required templates from proper trades.

C. Refer to Article 1.7 herein for fabrication tolerances.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where stone cladding is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

B. Review installation procedures and coordinate with other work, and with other trades whose work will be affected by the stonework.

C. Advise other trades of requirements relating to their placement of any inserts which are to be used for anchoring and supporting of stonework.

3.2 INSTALLATION

A. Sample Section of Stone Cladding

1. Prior to general installation of stone cladding, install a section of the wall (used as "control section") in accordance with final approved shop drawings. Architect shall be informed of time and place of such installation of control section.

2. Obtain Architect's acceptance of visual qualities of control section before start of general installation. Replace unsatisfactory work, as directed, until acceptable to the Architect. Retain control section in permanent work as a standard for judging completed work.

B. Qualification of Workmen: All work shall be performed by skilled workmen, especially trained and experienced in this type of work.

C. Lines and Grades: Benchmarks for elevations and building line offset marks for alignment shall be established on each floor level by the Contractor, who shall be responsible for their accuracy. Should any error be found in their location, the Installation Contractor shall so notify the Contractor in writing and installation work shall not proceed in the affected areas until the errors have been corrected.

D. Workmanship: All parts of the work shall be erected plumb and true, in proper alignment and relation to established lines and grades, and as shown on approved shop and/or erection drawings.

E. Erection Tolerances

1. Permissible dimensional tolerance in the building frame and/or work surrounding or supporting the work of this Section are stated in the appropriate Trade Sections of these Specifications.

2. The work shall be designed to accommodate all tolerances and anticipate dead and live load movement, creep, sway and torsion of the structure without any harmful effects.

3. Refer to Article 1.7 herein for stone erection tolerances.

F. Do not use stone units with chips, cracks, voids, stains or other defects which might be visible in the finished work. Patching or hiding defects in stone will not be permitted.

G. Clean stone before setting by scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives. If not thoroughly wet at time of setting, drench or sponge stone. Do not wet expansion or control joint surfaces.

3.3 SETTING STONE

A. Setting Mortar: Conform to ASTM C 270 Type N, Portland cement/lime mortar.

B. Pointing Mortar

1. 1 part non-staining white cement with color ingredient

2. 6 parts clean selected white sand to be compatible with the colored cement; sand to pass No. 16 sieve

3. 1 part hydrated lime to make as still a mix as can be worked

4. Water as required

C. Mixing

1. Mix cementitious materials, admixtures, and aggregate with the proper amount of water consistency which will result in a homogeneous, still and plastic mix.

2. Mix mortar in small batches by approved mechanical mixes. Monitor volume of materials per batch carefully.

3. Retempering of mortar will not be permitted, and mortar that has been allowed to stand more than one or two hours shall not be used. Mortar shall be mixed and kept tempered so that it will, at all times, contain as much water as it is able to carry.

D. Anchors

1. A minimum of 2 anchors shall be required on all pieces up to 2 square feet in area.

2. A minimum of 4 anchors shall be required on all pieces up to 20 square feet in area.

3. A minimum of 2 additional anchors shall be required on each additional 10 square feet.

E. Set stone and install stone support systems in accordance with drawings and final shop drawings for stonework. Provide anchors, supports, fasteners, and other attachments shown, or necessary to secure stonework in place. Shim and adjust accessories as required for proper setting of stone. Completely fill holes, slots and other sinkages for anchors, dowels, fasteners, and supports with mortar during setting of stones.

F. Before setting in the wall, all stones shall be thoroughly cleaned on all exposed surfaces by washing with fiber brush and soap powder, followed by a thorough drenching with clear water.

G. All stone joint surfaces not thoroughly wet shall be drenched with clear water just prior to setting.

H. Every stone shall be set in full beds of mortar with all joints slushed full. All joints shall be 3/8" unless otherwise noted.

I. Lead or plastic setting pads shall be placed under heavy stones, in sufficient quantity to avoid squeezing mortar out. Heavy stones or projecting courses shall not be set until mortar in courses below has hardened sufficiently to avoid squeezing.

J. Joints shall be raked out 1" and pointed with pointing mortar. If sealant joints are noted, joint shall be raked out full depth to receive back-up rod and sealant per Section 079200.

K. Weep tubes shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on drawings. Space weeps 24" o.c. unless otherwise noted.

L. Projecting stones shall be securely propped or anchored until the wall above is set.

M. In cold weather, International Masonry Industry All-Weather Council recommendations for setting from 40 deg. F. to 20 deg. F. shall be followed, except that no additives shall be used in the setting mortar, and below 20 deg. F. all work shall be done in heated enclosures.

3.4 REPAIRING AND CLEANING (AFTER ERECTION)

A. Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework. Patching or hiding defects in stone will not be permitted. Provide new matching units, install as specified and reseal joints to eliminate evidence of replacement. Reseal defective and unsatisfactory joints to provide a neat, uniform appearance.

B. Clean vertical stonework after completion of work, using clean water and stiff-bristle brushes. Do not use wire brushes, acid type cleaning agents or other cleaning compounds with caustic or harsh fillers.

3.5 PROTECTION

A. After installation and cleaning, protect stone work from damage during subsequent construction activities.

B. Protect all stone work from other material that will cause stain.

C. Provide protection for finished work such as jambs, exposed edges, corners, sills and all other stone liable to physical injury or staining. Protection shall include but is not limited to non-staining approved coverings, and clean non-staining wood boxing. All fastenings or hold-back devices shall be stainless steel. Fastening to stone joints is prohibited.

D. At completion of construction work, remove all temporary protection from the work of this Section.

E. Examine all work and repair all damage. Clean soiled or stained surfaces. In the event damage is irreparable, or soiled or stained surface cannot be cleaned, then remove and replace such items at no additional cost.

END OF SECTION

SECTION 04 43 02

MONOLITHIC STONE SITEWORK

PART 1 — GENERAL

1.1 SUMMARY

A. Section Includes:
1. Granite for Monolithic Stone Benches
2. Fieldstone for Dry Stacked Stone Wall

B. Related Sections - Examine Contract Documents for requirements that affect the work of this Section. Other Specification Sections that relate directly to work of this Section include, but are not limited to:

1. Section 079201, EXTERIOR JOINT SEALANTS - SITEWORK; Sealants for expansion joints and other joints indicated to receive sealant.
2. Section 321313, LANDSCAPE CONCRETE; Foundations and footings.

1.2 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Society for Testing and Materials (ASTM):
C 97 Absorption and Bulk Specific Gravity of Natural Building Stone
C 170 Compressive Strength of Dimension Stone
C 615 Structural Granite
C 880 Flexural Strength of Natural Building Stone

2. National Building Granite Quarries Association, Inc. (NBGQA):
Specifications for Architectural Granite

1.3 SUBMITTALS

A. Samples: Provide the following samples for approval by the Landscape Architect:

1. Monolithic granite sample: provide a 6 in. x 6 in. sample that fully demonstrates color, shade, veining, texture, range, and finish.

2. Fieldstone samples: provide 3 stones (min 6”x 12”) that provide representative sense of the range of the stone color and texture.

B. Manufacturer's Product Data: Manufacturer's product data shall be submitted for the following items:

1. Expansion joint filler

2. Grout materials, including additives

3. Mortar colorant for all applications

4. Mortar materials, including additives

5. Adhesive epoxy mortar

C. Shop Drawings: Cutting and setting drawings of granite bench shall be submitted. Drawings shall indicate sizes, dimensions, layout, finishes, arrangement and provisions for jointing, anchoring, cut-out and holes, and other necessary details for reception of other work.

1. Drawings shall indicate locations of inserts for any stone anchors and supports which are to be built into concrete, and locations and dimensions of cut-outs, holes, openings, and other provisions required for the work of other trades.

2. Shop drawings shall indicate the setting number of each piece and each piece shall bear the corresponding number in a non-staining paint.

D. Contractor's Review: Before commencing work, submit signed statement that Contract Documents have been reviewed with qualified representatives of granite and bluestone suppliers, and that selected materials and construction are proper, compatible, and adequate for application shown.

E. Test Report: Submit reports from tests conforming to ASTM C 67 methods indicating:

1. Compressive strength, psi. (ASTM C 170)

2. Density, lbs./c.f. (ASTM C 97)

3. Absorption by weight, % (ASTM C 97)

4. Abrasion resistance (ASTM C 241)

5. Flexural strength psi, (MPa) (ASTM C 880)

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer with not less than 10 years' experience and who has successfully completed stonework similar in material, design and extent to that indicated for this project. Submit list of completed projects; include project names, addresses and contact information. For each project, submit photographs showing detail of installed stone masonry.

B. Source:
1. Stone shall be supplied by a source approved by the Landscape Architect Owner's Representative.

2. Provide each type of stone from only one quarry to ensure consistent color range and texture. Do not change source during the course of the work.

C. Stone shall be standard grade, free of cracks, seams, starts, or other defects which may impair its strength, durability or appearance. Exposed surfaces shall be free from spots, spalls, chips, stains, discoloration, or other defects which would affect its appearance.

D. Mock-ups: Provide sample mock ups as indicated before commencement of further work. Re-work mock-up as required until approved by Landscape Architect. Do not proceed with work until mock-up is approved. Mock-up may be installed and remain as part of the permanent construction assembly if found acceptable by the Landscape Architect.
1. Provide a 4x4' sample panel of field stone wall displaying intended jointing, stone pattern, and range of stone color.

1.5 COORDINATION

A. Coordinate work with that of other sections affecting, affected by, this work, as necessary to assure the steady progress of the work under the Contract.

B. Do all cutting and drilling to accommodate work of other sections, as expressly indicated and as reasonably inferred from Contract Documents, Specifications, or required for the proper completion of the Work.

1.6 DELIVERY, HANDLING AND STORAGE

A. All stone shall be carefully packed and banded by the supplier for shipment. Following shipping granite shall be stored on wood skids or pallets, covered with non-staining, waterproof membrane and protected from the weather. Skids shall be placed and stacked in such a manner as to evenly distribute the weight of the stone materials and to prevent breakage, cracking, and damage to granite pieces. Stone shall be stored in such a manner as to allow air to circulate around the stone material. Stone shall not be permitted to be in direct contact with the ground any time during storage.

B. Stone shall be carefully handled to prevent chipping, breakage, soiling, or other damage. Pinch or wrecking bars shall not be used without protecting edges of stone with wood or other rigid materials. Stone units shall be lifted with wide-belt type slings wherever possible; wire rope or ropes containing tar or other substances which might cause staining or damage to stone finish shall not be used.

C. Stone damaged in any manner will be rejected and shall be replaced with new materials at no additional cost to the Owner.

1.7 JOB CONDITIONS

A. Finished surfaces adjacent to the stone work shall be adequately protected from soiling, staining, and other damage.

B. Cold Weather Protection:
1. Remove any ice or snow formed on granite or concrete bed by carefully applying heat until top surface is dry to touch.

2. Remove granite work determined to be damaged by freezing conditions.

3. Perform the following construction procedures while work is progressing:

Air Temperature	Procedures
40º - 32ºF	Heat sand to produce mortar temperatures between 40º and 120ºF
32º - 25ºF	Heat sand to produce mortar temperatures between 40º and 120ºF. Maintain temperature of mortar on boards above freezing.
25º - 20ºF	Heat sand to produce mortar temperatures between 40º and 120ºF. Maintain temperature of mortar on boards above freezing. Use wind breaks when wind is in excess of 15 mph.
20ºF – below	Heat sand to produce mortar temperatures between 40º and 120ºF. Provide enclosures and auxiliary heat to maintain air temperature above 32ºF. Do not lay units which have a surface temperature below 20ºF.

4. Latex admixture shall be kept at 40ºF minimum.

C. Cold Weather Protection for completed stone work:
1. Do not use frozen materials or materials mixed or coated with ice or frost. Do not lower the freezing point of mortar by use of admixtures or antifreeze agents, and do not use calcium chloride in mortar or grout.

2. Do not build on frozen work; remove and replace stone work damaged by frost or freezing.

3. During all seasons, protect partially completed stone work against weather when work is not in progress.

PART 2 — PRODUCTS

2.1 GRANITE FOR STONE BENCHES

A. Granite shall be sourced from Champlain Stone Ltd, Warrensburg, NY; tel: 518-623-2902; info@champlainstone.com, or approved equal
1. Color: Corinthian Granite
2. Dimensions: As shown in drawings
3. Finish: Thermal finish on top, saw cut finish at joints, hand-tooled finish on all exposed vertical faces.

B. Granite shall be cut oversize and exposed vertical faces shall be hand-tooled to accurate required dimensions.

C. All faces shall be at right angles to the plane of the top unless shown otherwise in drawings.

D. Holes, cut-outs, sinkages and openings in granite work for anchors, cramps, dowels, supports, and lifting devices, shall be accurately cut or drilled to required dimensions, as shown on the approved shop drawings, and as necessary to secure granite in place to insure correct location and accurate fit of all fixtures. Setting beds shall be shaped to fit supports.

E. Arrises shall be cut sharp and true to square, and continuous with adjoining arrises. Where exposed, arrises shall be eased.

F. Exposed top edges and corners to have a smooth, uniform, and consistent radii as indicated in the drawings.

2.2 FIELDSTONE FOR STACKED STONE WALL

A. Fieldstone shall be sourced from Johnston & Rhodes Bluestone Co, East Branch, NY; tel 607-363-7595; info@johnstonandrhodes.com or approved equal.
1. Product: Random Fieldstone.
2. Dimensions shall vary.
3. The character of the arrangement is shown on the Drawings.

2.3 SETTING BED MORTAR – THICK SET

A. Setting bed mortar shall be equal to "Laticrete 3701 Fortified Mortar Bed", a polymer fortified blend of carefully selected polymers, portland cement and graded aggregates, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal. Mix with water according to manufacturer's instructions.

2.4 THIN SET BED AND/OR BOND COAT

A. High strength bond coat between concrete base slab and setting bed mortar, and between setting bed mortar and stone, or thin set mortar bed, shall be equal to "Laticrete 254 Platinum", one-step, polymer fortified, thin-set mortar bond coat, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal.

2.5 MORTAR GROUT FOR POINTING

A. Sanded Grout: shall be 1500 Sanded Grout, a premium, factory prepared grout designed to be mixed with water. 1500 Sanded Grout is formulated from a blend of high strength portland cement, graded aggregates, polymers and color-fast pigments and provides a grout joint that is dense, hard and durable, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal.

1. For grout joint widths of 1/16" (1.5 mm) up to 3/8" (9 mm).
2. Color shall closely match color of stone.

2.6 EXPANSION JOINT FILLER

A. Preformed expansion joint filler shall be a nonextruding, resilient, nonbituminous type, conforming to ASTM D 1752, Type II.

2.7 ANCHORAGE AND SETTING MATERIALS

A. Anchors, dowels, shims, and other metal items required for the support and anchorage of the stone work shall be furnished under this Section.

B. Anchors, dowels, shims, and other metal items, shall be Type 316 stainless steel.

PART 3 — EXECUTION

3.1 ACCEPTABILITY OF CONCRETE BASE

A. Contractor shall examine the concrete foundation to determine its adequacy to receive stone work and mortar setting bed. Evidence of inadequate condition shall be brought to the immediate attention of the Landscape Architect.

B. Start of work of this Section shall constitute acceptance of the concrete foundation.

3.2 INSTALLATION

A. All setting shall be done by competent masons under adequate supervision and in accordance with the approved shop drawings.

B. Stone units with chips, cracks, stains, or other defects which might be visible in the finished work shall not be used.

C. Before setting, stone shall be clean and free of dirt, and foreign matter on all sides. Stone shall be dry before setting.

D. Thick set bed: shall be spread evenly over the troweled bond coat. Mortar setting bed shall be 1 in. thick, minimum.

1. Bond coat shall be applied to concrete base using flat trowel. Thickness of bond coat shall be approximately 1/16 in. to 3/32 in.
2. Mortar bed shall be spread evenly over the troweled bond coat. Bond coat shall be applied to mortar bed using flat trowel to thickness of 1/16 in.

E. Thin set bed: where indicated on the Drawings, shall be spread evenly over the concrete base. Mortar setting bed shall be 1/2 in. thick, maximum.

F. Stone shall be set true to the required lines and grades. Joints shall be uniform in thickness.
1. Expansion joints shall be 1/2 in. wide. Preformed joint filler shall be installed between units at expansion joint locations. Unless otherwise indicated on the Drawings all other joints shall be 1/4 in. wide. Direct bearing contact between stone pieces shall be prohibited.

2. All joints except expansion joints, shall be completely filled with mortar, then raked out to a depth of not less than 3/4 in. Raked joints shall be brushed clean and pointed with colored mortar to a flat cut joint. Mortar grout between stone pieces shall be uniform in appearance, texture, and color. After initial set of mortar, joints shall be finished by tooling with a rounded, nonstaining jointer to produce a glassy-hard, polished, slightly, concave joint, free of drying cracks.

G. Exposed surfaces shall be kept free from mortar at all times. Any mortar smears shall be immediately removed with a clean sponge and clean water before mortar can set.

H. Holes, slots, and other sinkages for anchors, and dowels, shall be completely filled with mortar during setting.

3.3 FINAL CLEANING

A. Final Cleaning: After stones are set in final position, clean stone assemblies removing all dirt, excess mortar, stains, and other defacements as follows:

1. Mild abrasive cleaners that contain no harsh or caustic ingredients may be used, with fiber brooms or brushes and clear water.
2. Wire brushes, steel wool, and acids or other solutions which may cause discoloration are expressly prohibited.

B. Upon completion of stone work, surfaces shall be left in a clean, unsoiled condition, acceptable to the Landscape Architect.

3.4 PROTECTION

A. Stone work shall be properly and adequately protected under the responsibility of the Contractor until final acceptance of the Project by Owner.

B. After the stone work has been installed, it shall be properly and adequately protected from damage. Boxing or other suitable protection shall be provided by Contractor wherever required. However, no lumber which may stain or deface the stone shall be used. Nails shall be high-quality galvanized or non-rusting.

END OF SECTION

DIVISION 05
METALS

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes but is not limited to the following as shown on the drawings and as specified herein:

1. Furnish and deliver for installation by others, anchor bolts, bearing plates and loose lintels with complete instructions and templates to facilitate installation.
2. Furnish and erect all struts, columns, bearing plates, beams, steel trusses, girders, bracing, hangers and all related connections (bolted and welded).
3. Openings (unreinforced and reinforced) in structural steel to accommodate mechanical and electrical work.
4. Shop painting and field touch-up painting.
5. Erection bracing and supports, including steel wedges, shims or nuts required for leveling base plates.
6. Lintels and angles attached to structural steel as shown on drawings.
7. Unless specifically excluded, furnish and install all other items for structural steel work indicated on the drawings, specified, or obviously needed to make the work of this Section complete.
8. Waste Management

B. Related Requirements:

1. Division 01 Section “Construction Waste Management and Disposal”
2. Division 03 Section “Cast in Place Concrete”
3. Division 04 Section “Unit Masonry”
4. Division 05 Section “Metal Deck.”
5. Division 05 Section “Metal Fabrications.”
6. Division 06 Section “Rough Carpentry.”
7. Division 07 Section “Waterproofing.”
8. Division 07 Section “Joint Sealants.”
9. Division 07 Section “Expansion Joint Cover Assemblies.”
10. Division 31 Section “Dewatering.”

C. Related Work Specified Elsewhere

1. Installation of anchor bolts furnished under this section.
2. Grout under base and bearing plates.
3. Installation of loose lintels furnished under this section.
4. Miscellaneous metal work
5. Light gage metal roof trusses.
6. Stair framing and hangers.
7. Field painting of structural steel, except as specified herein.
8. Fireproofing systems.

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. The Contractor is to implement practices and procedures to meet the Project's Sustainable Design goals. The Contractor shall ensure that the requirements related to these goals, as defined in this Section and in Related Sections of the Contract Documents, are implemented. Substitutions, or other changes to the Work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's Sustainable Design goals.

B. The Contractor is to efficiently use resources and energy while executing the Work of this Section. Resource efficient aspects to be considered in completing this Project include the use of techniques that minimize waste generation, reuse of construction materials on site where possible, and recycling of waste generated during the construction process.

C. Performance Requirements: The following criteria are required for the products included in this section

1. Preference shall be given to materials within 500 miles of the project site, and those steel components originating from mills/fabricators located nearest to the building site.
2. All steel shall contain a minimum of 50% (combined) pre-consumer/post-consumer recycled content.
3. Adhesives, sealants, paints and coatings used for the work of this section shall meet the Volatile Organic Compound (VOC) limits specified below where applicable.
4. Maximize the re-use of salvaged steel (as approved by the Engineer of Record) and, for work on existing buildings, alert the design team to any existing steel which could be re-used but has not been indicated on the drawings.
5. Maximize the recycled content of all steel products.
6. Design details penetrating the façade strictly in accordance with the architectural and structural directives.
7. Where possible all connections should be made using bolted as opposed to welded details.
8. Where welding is required use Submerged Arc Welding (SAW). The Gas Metal Arc Welding (GMAW) shall be used were SAW is not applicable (such as for angled connections and anything irregular or short). Field welding shall be allowed only in special circumstances; in such cases Flux Core Arc welding (FCAW) shall be specified with the use of portable fume exhaust system.
9. Use surface preparation techniques that minimize the use of halogenated solvents and solvents classified as volatile organic compounds. Consider using 'weathering steel' (ASTM A 847) for exterior steel with the approval of the Architect and Engineer of Record.
10. Use high strength HSS round tubes instead of A36 Steel pipes with approval of the Engineer of Record.

1.4 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches .
2. Welded built-up members with plates thicker than 2 inches .
3. Column base plates thicker than 2 inches .

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of all connections required by the drawings to be completed by structural steel fabricator (including comprehensive engineering analysis by a qualified professional engineer) to withstand loads indicated and comply with other information and restrictions indicated, unless noted otherwise.

1. Select and complete connections using schematic details indicated and AISC 360.
2. Use design method indicated on structural drawings.
3. Moment Connections: Fully restrained unless otherwise noted on drawings.

B. Lateral Framing Resisting System: Type used is indicated on structural drawings.

1.6 SUBMITTALS

A. Product Data: Submit data for each type of product indicated in the contract documents.

B. Shop Drawings: Submit shop drawings in accordance with the specifications as follows:

1. Show clearly all work, including relationship of structural steel to the adjacent work of other trades and to significant lines of finishes of other trades.
2. Do not fabricate or deliver work to the site before drawings reviewed by the Architect and Engineer of Record have been returned.
3. Before preparing steel shop drawings, submit proposed submittal schedule for review by Architect and Engineer of Record.
4. Before preparing steel shop drawings, submit for review a set of job standards showing all necessary joint details with full particulars of connection pieces, shop and field welds, and holes for erection bolts and permanent bolts. These shall include any moment and shear connections. Appropriate marks for designating all types and sizes of joint details shall be included. After approval of these job standards, the erection plans are to be submitted and shall be marked to indicate unmistakably the type and size of joint to be used for every beam connection. Do not order steel in advance of approval of the job standards and the erection plans with joint marks, except at own risk
5. Submit calculations for design of connections on job standards and all other connections such as moment and brace frames. Calculations shall be signed and sealed by a Professional Engineer licensed in the state in which the project is located.
6. Prepare remainder of steel shop drawings after approval of job standards and erection plans. Drawings submitted prior to approval of job standards will be returned without review.
7. Prepare shop drawings in conformance with the applicable procedures shown in "*Detailing for Steel Construction*," latest edition, published by AISC. Prepare shop drawings under the supervision of competent engineering personnel, licensed by the state in which the construction is to take place. During the preparation of shop drawings, and prior to submittal, coordinate and cross check all shop drawings, including those prepared by subcontractors, for compliance with the Contract Documents.
8. Indicate clearly the size and grade of steel for each component. Identify rolled shapes, tubes and plates by using the standard designations used in "Steel Construction Manual" Latest Edition, by AISC.
9. Indicate welds and nondestructive tests by using the symbols conforming to AWS A2.4 "Symbols for Welding and Nondestructive Testing." Where necessary for clarity, indicate welding procedure designations or other data in the tail of the welding symbol.
10. Show explicitly the type of connection used in each location, including the grade, size, and number of bolts;

the type, number, position, designation and orientation of each washer; and the size of each hole, whether slotted or round. Ensure that adequate wrench clearance for correct bolt tightening is provided and note special bolt tightening sequences where applicable and necessary.

11. Show all camber dimensions in the shop drawings. Where specific camber is not shown in the drawings, note on each affected shop drawing that such members are to be fabricated with the natural camber up.
12. Show holes required for securing work specified in other sections to structural steelwork, as well as all holes required for passage through structural steelwork of work of other trades. Provide field work drawings for all such holes not shown in shop or erection drawings. Addition of, or change in size or location of openings will not be permitted without prior approval.
13. Use bolted connections wherever possible; avoid field welding unless otherwise noted on drawings.
14. Make details in such a way as to avoid having steel, connections, bracing, bolts, etc., interfere with architectural details or in any way reduce the areas of shafts, openings, clearances, etc.
15. Detail and schedule cleaning and painting data and requirements, including specific indication of "no-paint" areas.
16. The use of the Architect's or Engineer of Record's electronic drawing files as a base for the erection shop drawings will be permitted at the request of the structural steel detailer upon completion and return of the waiver form. The use of the Architect's or Engineer of Record's electronic drawing files as a base for shop drawing details will not be permitted. The structural steel detailer will be responsible for compatibility of the files with his hardware or software. The electronic files are not to be considered the contract documents, the design team makes no representation regarding the accuracy or completeness of the electronic files given to the structural steel detailer and their use will be at the structural steel detailer's sole risk and without liability to the design team. The structural steel detailer shall remove the project title box and all references to the structural drawings including drawing numbers and structural drawing sections and details. The structural steel detailer shall also remove all reference to work not included in the steel contract.
17. Scaling of the Architect's or Engineer of Record's drawings is not permitted. This applies to hard paper, electronic, and all other versions.
18. Show clearly the size and location of each member and the erection mark assigned to each member. Show each field connection with all data and details necessary for assembling the structure. Direct special attention to the possible need for special guying, bracing, or shoring to prevent deformation of existing or new structure due to stresses caused by erection procedures and equipment, by construction loadings, and by forces of natural phenomena.
19. Prepare, keep up-to-date, and submit a complete drawing index cross-referencing each assigned piece mark with the drawing number in which the piece is detailed. Detail drawings submitted without an up-to-date index and the applicable erection drawing(s) showing the location of each piece will be deemed an incomplete submission and will not be accepted as subject to any agreed shop drawing review schedule.
20. Prepare anchor bolt and base plate erection drawings containing complete location and placing details, including details of all templates. Provide anchor bolt erection drawings to the concrete trade in advance of applicable concrete work and in coordination with concrete construction sequence.
21. Submit, in writing, any proposed deviations from the Contract Documents, prior to the submission of shop drawings showing the proposed deviation. Submit requests for deviations on the steelwork subcontractor's letterhead. Deviations not identified, or identified only in letters of transmittal or in shop drawings or both, without the required written request, may not be accepted, and shall be sufficient cause for the architect to return each shop drawing containing such deviations without further action. Acceptance of shop drawings containing deviations not detected by the architect during shop drawing review shall not relieve the steelwork subcontractor from responsibility to conform strictly to the Contract Documents.
22. Prior to resubmission of shop drawings with additions or corrections, circle or bubble and identify all changes. Drawings submitted without each change being clearly identified are subject to return for resubmission.
23. Prior to making shop drawings for any portion of the work involving alterations to an existing structure, make all necessary field observations, measurements and surveys of existing conditions. If probes are required to accomplish such measurements, give timely notice where probes will be required.

C. Submit certified copies of each survey conducted by a surveyor licensed by the state in which the construction is to take place and employed by the structural steel subcontractor. Survey shall show elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate

discrepancies between actual installation and Contract Documents.

D. Reports:

1. Submit certified copies of mill test reports for all steel furnished. Perform mechanical and chemical tests for all material regardless of thickness or use.
2. Submit certification of recycled steel content. Certification shall clearly indicate post-consumer AND post-industrial recycled steel content for the particular member or members used.
3. Submit anchor bolt checking certification as required.
4. Submit qualification certificates of all welders who will perform work on the project.
5. Submit survey of erected steelwork as required.

E. Submit verification of bio-degradable or low VOC, and low Hazardous Air Pollutants (HAPS) cleaning solutions. Provide a cut sheet for all cleaning solutions used in the surface preparation of steel components. Highlight VOC limits and chemical component limits.

1.7 QUALITY ASSURANCE

A. Except as modified by this specification, comply with the applicable provisions and recommendations of the following codes and standards:

1. New York State Building Code, Latest Edition
2. AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".
3. AISC "Code of Standard Practice for Steel Buildings and Bridges" latest edition.
4. AISC “Seismic Provisions for Structural Steel Buildings”, latest edition.
5. Industrial Fasteners Institute "Handbook of Bolt and Bolted Joints" latest edition.
6. RCSC "Specifications for Structural Joints Using High-Strength Bolts."
7. ASTM Standards as applicable in the building code of the local jurisdiction and as noted in this specification.
8. AWS D1.1, "Structural Welding Code."
9. AWS A5.18 & A5.28, Structural Welding Code for GMAW
10. SSPC "Painting Manual, Volume 2, Systems and Specifications.", Latest edition.

B. Qualifications for welding work shall be as follows:

1. Qualify welding procedures and welding operators in accordance with the AWS "Standard Qualification Procedure."

    a. Include amended requirements of the building code as noted above.

2. Submit certification that all welders to be employed in work are AWS qualified. If re-certification of welders is required, retesting will be responsibility of structural steel subcontractor.

    a. Include licensing requirements as per the building code noted above and local jurisdiction.

1.8 TESTING AND INSPECTION

A. Special Inspection as required by the applicable Building Code of all structural steelwork in the shop and field will be performed by an inspection agency retained by the Owner at no expense to the Contractor. The inspection agency shall work under the direction of the Owner. Contractor shall provide the inspection agency with the following:

1. Schedule of all work in both shop and field with at least ten days' written notice before commencement of

either activity.

2. A complete set of approved shop and erection drawings.
3. Cutting lists, order sheets, material bills, shipping bills and mill test reports.
4. Information as to time and place of all rollings and shipment of material to shops.
5. Representative sample pieces as requested by the testing agency.
6. Full and ample means and assistance for testing all material.
7. Proper facilities, including scaffolding, temporary work platforms, etc., for inspection of the work in the mills, shop and field.

B. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the inspector can refer back to the person making the connection.

C. The following minimum criteria shall be adhered to in testing of welds and bolts:

1. All welds and bolts shall be examined by visual means.
2. 25% of all welds, selected randomly, shall be measured.
3. EXACT INSPECTION ROUTINE FOR BOLTED JOINTS DEPENDS ON THE TYPE OF JOINT AND INSTALLATION METHOD. FOR PRETENSIONED AND SLIP-CRITICAL JOINTS, NOTE THAT A PRE-INSTALLATION VERIFICATION OF THE PRETENSIONING METHOD IS PART OF THE REQUIREMENTS, USING A TENSION CALIBRATOR, PER SECTION 7 OF THE RCSC SPECIFICATION.
4. Bolted joints shall be verified per the RCSC “Specification for Structural Joints Using High-Strength Bolts,” Section 9, based on installation method.
5. All welds subject to tensile stress shall be examined by the Ultrasonic Method for 100% of their length.
6. 10% of all manual fillet welds shall be tested by the magnetic particle method.
7. 1'-0" at each end of automatic fillet welds shall be tested by the magnetic particle method.
8. 100% of groove welds shall be tested by the ultrasonic method.

D. Shop inspection will include examination of steel for straightness and alignment, fissures, mill scale, and other defects and deformities, as described in ASTM A6, examination of fabricated pieces for conforming to approved shop drawings, testing of bolts and welds, and inspection of shop painting. All shop welds shall be visually inspected and spot tested using Ultrasonic Method ASTM E 114 and AWS, Chapter 6, Part C. All inspected welds shall be identified by the inspector.

E. Field inspection will include examination of erected steel for welding, proper fitting and tensioning of bolts, alignment, trueness and plumbness, touching-up of shop coat, level of billets and base plates.

F. Inspection of welding will be such as to assure that the work is within the quality requirements specified below and elsewhere in this section of the specifications and will include:

1. Ascertainment that the electrodes and flux used for the SAW, GMAW and FCAW welding processes conform to the requirements of this section of the specifications.
2. Ascertainment that the approved welding procedures and sequence are followed without deviation, unless specific approval for change is obtained from the Engineer of Record.
3. The testing agency shall be prepared to utilize the following approved methods of testing:

    a. Liquid penetrant inspection: ASTM E 165.
    b. Magnetic particle: ASTM E 1444.
    c. Radiographic inspection: ASTM E 94 and E 1032.
    d. Ultrasonic inspection: ASTM E 114 and AWS, Chapter 6, Section C.

G. When defects are revealed, additional inspection by whatever method is deemed necessary by the inspector, shall be performed to the extent necessary to assure that the full amount of defect has been located. No further work shall be done on the assembly or sub-assembly in question until all the necessary corrections have been made.

Defects shall be repaired, using the same welding procedure that was used initially in making the weld, unless otherwise approved by the Engineer of Record. Inspection of the repaired weld shall be by the same method that was used to reveal the defect. A second repair of a defective area shall not be made without approval of the Engineer of Record.

H. Apparatus and procedures for measuring required tension in pretensioned and slip-critical high strength bolted connections shall be furnished and maintained by the steel contractor, in accordance with the RCSC “Specification for Structural Joints Using High-Strength Bolts,” and shall be approved by the inspection agency. The inspection agency shall observe the pre-installation verification testing required and shall ensure by routine observation that the bolted installations conform to the approved pretensioning method being used. The steel contractor shall provide a laborer and scaffolding as required for the testing of connections by the inspection agency, and shall, at his own expense, furnish such facilities and provide such assistance as may be required for proper inspection.

I. A distinguishing mark will be placed on all work that has been inspected and approved. Material or work that is not acceptable will be designated by words such as "REJECT" or "REPAIR" marked directly on the material or work.

J. Inspection of Shop Painting:

1. Visually evaluate surface preparation by comparison with pictorial standards in accordance with SSPC-Vis 1.
2. Measure dry film thickness of each coat with a magnetic film thickness gauge in accordance with SSPC-PA 2.
3. Visually inspect dried film for runs, sags, dry spray, overspray and missed areas.
4. Repair defective or damaged areas in accordance with painting requirements specified. Architecturally exposed structural steel shall be free of runs and holidays. Make repairs to shop or field coat as directed.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work. Minimize the disturbances to site and soil conditions.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members in a safe, dry, off ground location, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration, discoloration or staining.

D. Do not store materials on structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structures as directed.

1.10 PROJECT CONDITIONS

A. The structural steel contractor shall coordinate the structural steel work with the work of other Contracts. Verify all dimensions and details of this Contract and those of other Contracts that affect the work before proceeding. Any discrepancies shall be immediately reported to the architect.

B. Be fully responsible for the accurate installation of the work. Any discrepancy which arises from his failure to execute the work in conformity to the drawings and specifications shall be properly remedied at the contractor's own expense and in a manner acceptable to the architect.

C. Locate dimensionally on setting plans all anchor bolts, inserts, bearing and base plates, etc., and prepare and

deliver all required templates and fully dimensioned setting plans in time for the proper execution of the work. Anchor bolts shall be set by another subcontractor. The structural steel contractor shall check all such settings for correctness after they have been cast in place, and before proceeding with erection work.

D. Report to the architect and certify compliance with the above checking requirements in writing and indicate any inaccuracies found in the location of anchor bolts or inserts, and corrections which must be made to their installation. Any inaccuracies not included in the report and found during or after steel erection shall be the responsibility of the structural steel contractor and the cost of corrective measures shall be borne by the structural steel contractor.

E. Use base lines, bench marks, or other standards for survey work that have been provided or verified by others. If permanent building bench marks have been established, these will be used for field checking.

F. Coordinate with all other trades to insure that work of this section does not cause undue conflict. Insure that location of erection devices such as cranes, derricks, booms or hoists, does not cause over-stresses to steel frame to work previously placed by other trades or to existing structures. When required, retain the services of a licensed professional engineer to ascertain that erection devices do not create unsafe conditions or cause overstresses.

G. Ensure full co-ordination with other related trades and professions.

1.11 SUBSTITUTION

A. Architect reserves the right to require substitute shapes of other sizes than those indicated on the drawings when it is apparent that the shapes specified cannot be furnished within the time required for the progress of construction. Make said substitutions without additional cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel shapes, including structural steel wide flange and structural tee rolled shapes, channels, angles, plates, pipe, and hollow structural sections: As noted on structural drawings.

B. High Strength Bolts: As noted on Structural Drawings.

C. Anchor Rods: As noted on structural drawings

D. Filler metal for welding electrodes. As noted on structural drawings.

E. Structural steel primer paint: rust inhibitive primer conforms to the following criteria

1. Demonstrate a minimum of adhesion as classified by 4B of ASTM D 3359 method A
2. Demonstrate a minimum opacity as determined by ASTM D 2805
3. Demonstrate corrosion resistance per standards ASTM B 117 & ASTM D 5894
4. “Slip Critical” compatible rating where applicable
5. The product shall not contain any of the prohibited compounds as listed in Green Seal *Standard for Paintings and Coatings*, GS-11, latest edition and in Master Painters Institute (MPI) *Green Performance Standard*, GPS-1-08.
6. The product shall meet the VOC limits as set forth in the MPI Green Performance Standard, GPS-1-08, with a maximum allowable VOC of 340 g/L for rust preventative coatings. Limits are expressed in THINNED state. Preference shall be given to products with the least crystalline silica content.
7. The product shall meet all the requirements of MPI Standards: 23, 26, 76, 79, 95, 107, 135, 173, 275.

Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category.

a. Exterior exposed steel, normal conditions: Use alkyd or polyamide solvent based paints (MPI #'s 76, 79 & 101)
b. Interior exposed steel: Use water based paint (MPI # 107)
c. Special Applications, highly corrosive environments: Use zinc rich paints (MPI #'s 20 & 200)

F. Structural steel field paint for exposed members: rust inhibitive primer conforms to the following criteria

1. Demonstrate a minimum of adhesion as classified by 4B of ASTM D 3359 method A
2. Demonstrate a minimum opacity as determined by ASTM D 2805
3. Demonstrate corrosion resistance per standards ASTM B 117 & ASTM D 5894
4. "Slip Critical" compatible rating where applicable.
5. The product shall not contain any of the prohibited compounds as listed in Green Seal *Standard for Paintings and Coatings*, GS-11, latest edition and in the Master Painters Institute *Green Performance Standard*, GPS-1-08.
6. The product shall meet the VOC limits as set forth in the MPI Green Performance Standard, GPS-1-08, with a maximum allowable VOC of 400 g/L for rust preventative coatings. Limits are expressed in THINNED state. Preference shall be given to products with the least crystalline silica content.
7. The product shall meet all the requirements of MPI Standards: 23, 26, 76, 79, 95, 107, 135, 173, 275. Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category. Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category.

a. Exterior exposed steel, normal conditions: Use alkyd or polyamide solvent based paints (MPI #'s 23, 79)
b. Interior exposed steel: Use water based paint (MPI # 107)
c.

PART 3 - EXECUTION

3.1 FABRICATION

A. All shop connections shall be high strength bolted unless specifically shown otherwise. Fabricate work in shop in as large assemblies as practicable. Use welded connections ONLY where shown on drawings. If a bolted connection is not possible, obtain written approval from the Engineer of Record for the welded connection.

B. Camber: As indicated on drawings.

C. Mill column ends and bearing stiffeners to give full bearing over the cross section. Plane contact surfaces of bearing plates when required by the AISC Specifications. It is not necessary to plane bottom surfaces of plates on grout beds.

D. Drill or punch holes at right angles to the surface of the metal, not more than 1/16" larger than the connector diameter. Do not make or enlarge holes by burning. Drill material having a thickness in excess of the connector diameter and material thicker than 7/8". Holes shall be clean-cut without torn or ragged edges. Remove outside burrs resulting from drilling operations.

E. Provide holes in members to permit connection of the work of other trades. Use suitable templates for proper location of these holes. Steel requiring adjustment or accurate alignment shall be provided with slotted holes or full bearing shims as shown.

F. Provide holes, slots and openings required by other trades together with necessary reinforcing required. Use suitable templates for proper location of these openings. All such openings shall be shown on the shop drawings. No change in size or location will be permitted without prior approval.

G. Manual flame cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is within 1/8" of the required line.

3.2 SHOP CONNECTIONS

A. Provide connections as shown on the drawing exactly as detailed. Where connections are not detailed, the minimum connections shall comply with appropriate tables headed, "Framed Beam Connections" shown in the AISC "Manual of Steel Construction" unless otherwise noted on the drawings. Use high strength bolts unless otherwise shown.

B. Do not use welded connections unless shown on details. Field welding is not allowed without written instruction from the Engineer of Record.

C. Proportion and detail all connections on shop drawings to resist forces shown on design drawings.

D. Bolting

1. Bolts shall be of a length that will extend not less than 1/4" beyond the nuts. Enter bolts into holes without damaging the thread.
2. Joint Type: As noted on the Structural Drawings.
3. Make high-strength bolted joints without the use of erection bolts. Bolt heads and nuts shall rest squarely against the metal. Where structural members have sloping surface, bolted connections shall be provided with beveled washers to afford square seating or framing for bolt heads or nuts.
4. All joints are to be compacted to the snug-tight condition in accordance with Section 8 of the RCSC “Specification for Structural Joints Using High-Strength Bolts.” Protect bolt heads and threads from damage during installation.
5. Pretensioned and slip-crtical joints are to be installed by one of the methods prescribed in Section 8.2 of the RCSC “Specification for Structural Joints Using High-Strength Bolts,” unless written approval is obtained from the Engineer of Record.
6. Bolts that have been completely tightened shall be marked for identification.

E. Welding

1. The following environmentally preferable welding processes shall be used as described for the related application without exception:

    a. Submerged Arc Welding (SAW): Plate girders, fillet and butt joints in pipes, cylinders, columns and beams, and welds where ‘downhand’ or horizontal positions are possible.
    b. Gas Metal Arc Welding (GMAW) shall be used where SAW is not applicable (such as for angled connections and anything irregular or short).
    c. Field welding shall be allowed only in special circumstances; in such cases Flux Core Arc welding (FCAW) shall be specified

2. Do not begin structural welding until joint elements are inspected for surface preparation, fit-up, and cleanliness of surface to be welded and are then bolted or tacked in intimate contact and adjusted to dimensions shown on drawings, or both, with allowance for any weld shrinkage that is expected. No members are to be spliced without prior approval by the Engineer of Record.

a. Containment surface preparation debris must meet SSPC-Guide 6 guidelines.

3. Pre-heat and interpass temperature shall be in accordance with Table 4.2 (including footnotes) of the AWS Code for Welding in Building Construction. The temperature shall be measured from the side opposite to that which the pre-heat is applied, where possible.
4. All groove welds shall be continuous and full penetration welds unless otherwise shown on the design drawings. Welds made without the aid of a back-up bar shall have their roots chipped, ground or roughened out to sound metal from the second side, before welding is done from the second side.
5. All welds shall be sound throughout. There shall be no crack in any weld or weld pass. Weld may be considered sound if it contains only slight porosity or fusion defects which are well dispersed.
6. The heat, input, length of weld and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.

3.3 SHOP PAINTING AND CLEANING

A. Finishing, coating, plating

1. Shop painting and factory finishing shall be preferred to field painting whenever possible. Where applicable, finishes and surface preparations based on a physical process such as abrasive blasting, grinding, buffing and polishing are preferred to coatings and solvent based cleaning. Where coatings are necessary powder-coated fabrication is preferred to painting and plating. Avoid plated metals especially those using cadmium and chromium as plate material or cyanide or copper/formaldehyde based electroless copper as the plating solution.

B. Remove all rust, scale, grease and other detrimental foreign matter in accordance with SSPC-SP 3, Power Tool Cleaning, unless conditions/opportunities listed below apply.

1. Use surface preparation classification recommended by paint manufacturer, SSPC or Master Painters Institute (MPI) for paint product used.

a. SSPC-Guide 6, Guide for Containing Debris Generated During Paint Removal Operations, must be followed for all applicable surface preparation techniques.

C. Immediately after surface preparation, apply structural steel primer paint where specified, in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 2.0 mils. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces. Use type of primer paint as specified in "Materials" article above. Apply two coats to surfaces that will be inaccessible after erection

D. Paint all structural steel in accordance with the foregoing specification, except as follows:

1. Steel which is to receive spray-on fireproofing.
2. Within 2" of field welds or welds made after paint is applied.
3. Faying surfaces in bolted connections shall be prepared per Section 3.2 of the RCSC “Specification for Structural Joints Using High-Strength Bolts.”
4. Machined surfaces and threaded parts required for adjustment of the structure. Protect these with suitable rust inhibiting coating which may be removed after final installation of the work so that proper finished coatings may be applied.

3.4 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to

ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

3.5 SOURCE QUALITY CONTROL

A. Refer to testing and inspection requirements specified above.

3.6 EXAMINATION

A. Verify field measurements prior to start of erection. Check the alignment and elevation of all column supports and location of all anchor bolts with transit and level instruments before starting erection. Notify architect of any errors. Obtain Architect's approval of methods proposed for correcting errors prior to proceeding with corrections and erection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.7 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.8 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Column billets and bearing plates shall be supported and aligned on steel wedges, shims, or leveling nuts. After the supported members have been plumbed and properly positioned by instrument and anchor nuts tightened, the entire bearing area under the plate shall be packed solidly with grout specified in another Section. Wedges and shims shall be set back a minimum of 3/4" from the edges of plates and shall be left in place. Leveling plates are not permitted.

D. Plumbing, Leveling and Bracing

1. Structural steel shall be erected true and level, and temporary bracing shall be introduced wherever necessary to provide for all loads to which the structure may be subjected, including equipment and the operation thereof. Such bracing shall be left in place as long as may be required for safety. No welding shall be done or bolts drawn up tight until structural steel has been properly aligned. Obtain approval for guy locations to assure lack of interference with operations of other trades.

E. Drifting

1. Light drifting necessary to draw holes together will be permitted, but drifting of unfair holes will not be

permitted. Twist drills shall be used to enlarge holes as necessary to the next larger size; use next larger size bolts as required. Reaming that weakens the members, or make it impossible to fill the holes properly or to adjust accurately after reaming, will not be allowed.

3.9 FIELD CONNECTIONS

A. In addition to the requirements for shop connections comply with the following:

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
2. Joint Type: As noted on structural drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

3.10 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 3, Power Tool Cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 9."

D. After erection, all damaged areas in shop coat, exposed surfaces of bolt heads, nuts and washers, and all field welds and unpainted areas adjacent to field welds and high strength bolts shall be painted with a "touch-up" application of same paint used in the shop coat and then painted with same paint used for shop coat tinted another color. Retouch in field, any scraped, abraded, and unpainted surfaces. Painting shall be as specified for shop coats.

E. Structural steel which is to support mechanical equipment and will be left exposed to the weather in the finished project shall be field painted with one coat of anti-corrosive paint as described in Part 2 for Paint Materials.

3.11 WASTE MANAGEMENT

A. Separate and recycle waste materials to the maximum extent feasible.

B. Separate for recycling and place in designated containers the following metal waste in accordance with the Waste Management Plans and local recycler standards: Steel, iron, galvanized steel, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass and bronze.

C. Collect all metal cut-offs and scraps and recycle as above.

D. Fold up metal banding, flatten and place in designated area.

E. Close and seal tightly all partly used paint and finish containers and store protected in a well-ventilated, fire-safe area at moderate temperature.

F. Designated un-used paint for:

1. Immediate re-use
2. Long term maintenance needs
3. Recycling by an appropriate facility.
4. Donation

G. Place empty containers of solvent-based paints in areas designated for hazardous materials.

H. Do not dispose of paints or solvents by pouring on the ground. Place amounts too small to re-use in designated containers for proper disposal

I. Place materials defined as hazardous or toxic waste in designated containers.

END OF SECTION

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

A. Section includes but is not limited to the following as shown on the drawings and as specified herein:

1. Floor deck
2. Roof deck
3. Headed shear studs
4. All necessary deck supports and reinforcing other than principal framing members including diagonals at columns, angles, plates, etc.
5. Flashing, cell closures, closure plates and sheet metal work required to contain concrete.
6. Ceiling hanger tabs at new decking composite with concrete where new suspended ceilings are required.
7. Waste Management.

B. Related Requirements:

1. Concrete and reinforcement over decking
2. Structural steel
3. Shoring of metal deck where unsupported span exceeds the allowable
4. Ceiling systems
5. Mechanical and electrical where supported from deck
6. Fireproofing systems
7. Sheet metal work
8. Waste Management/Recycling Strategies

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. The Contractor is to implement practices and procedures to meet the Project's Sustainable Design goals. The Contractor shall ensure that the requirements related to these goals, as defined in this Section and in Related Sections of the Contract Documents, are implemented. Substitutions, or other changes to the Work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's Sustainable Design goals.

B. The Contractor is to efficiently use resources and energy while executing the Work of this Section. Resource efficient aspects to be considered in completing this Project include the use of techniques that minimize waste generation, reuse of construction materials on site where possible, and recycling of waste generated during the construction process.

C. Performance Requirements: The following criteria are required for the products included in this section

1. Preference shall be given to decking containing raw materials harvested or extracted and processed within

500 miles of the project site.

2. All steel decking, and other steel products including but not limited to studs, reinforcement bar, fasteners, and clips required by the work of this section shall contain a minimum of 50% (combined) pre-consumer/post-consumer recycled content.
3. Adhesives, sealants, paints and coatings used for the work of this section shall meet the Volatile Organic Compound (VOC) limits, where applicable.
4. Where welding is required use Submerged Arc Welding (SAW). The Gas Metal Arc Welding (GMAW) shall be used were SAW is not applicable (such as for angled connections and anything irregular or short). Field welding shall be allowed only in special circumstances; in such cases Flux Core Arc welding (FCAW) shall be specified with the use of portable fume exhaust system.
5. Use surface preparation techniques that minimize the use of halogenated solvents and solvents classified as volatile organic compounds.

1.4 PERFORMANCE REQUIREMENTS

A. Metal deck unit sizes and gauges are indicated on the drawings. Gauges indicated on the drawings are a minimum. Thickness of deck may be required to be increased by deck manufacturer for loadings indicated on drawings.

B. Unit shall span over three or more supports except where steel layout does not permit.

C. Maximum allowable deflection under live load plus super imposed dead load shall not exceed (1/360) of the span or (1/4) inch whichever is less.

D. Deck shall be sized as unshored. Shoring of deck is not permitted unless specifically shown in areas on the drawings.

E. Use of piercing, non-piercing, and integral hanger tabs is not permitted at roof deck.

F. Units included in a fire rated assembly must be classified in appropriate UL design.

1.5 SUBMITTALS

A. Product Data: Product data, including manufacturer's specifications, load tables, section properties and installation instructions for each type of decking and accessories.

B. Shop Drawings: Shop drawings for all installations showing gauges, deck layout, type of deck, any shoring required, where located, welding details necessary for fabrication to fit in place, and all accessories. Do not use reproductions of the Design Drawings. In addition, include the following:

1. Ceiling tab, fillers, closures and similar items.
2. Show placement of headed shear studs connectors with respect to the flutes of the metal deck. Variation from the specified deck configuration may result in a decrease of the capacity of the studs, requiring more studs.

C. Product Certificates: Certification of specification compliance for each item specified.

D. Reports

1. Submit certification of recycled steel content. Certification shall clearly indicate post-consumer AND post-industrial recycled steel content for the particular member or members used.
2. Submit verification of finishing process:

    a. Provide a cut sheet and a Material Safety Data Sheet (MSDS) for all shop and field paints used

highlighting VOC limits and chemical and mineral component limits.

b. For heavy metals in used plating processes: Provide a cut sheet and a Material Safety Data Sheet (MSDS) for each plating material and related compounds highlighting chemical component limits.

c. Certification of recycled zinc content for galvanized products: Provide cut sheets clearly indicating whether the galvanized products used meet the minimums for post-consumer OR post-industrial recycled contents. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and if the recycled content is post-consumer or post-industrial.

3. Submit verification of biodegradable or low VOC, and low Hazardous Air Pollutants (HAPS) cleaning solutions. Provide a cut sheet and a Material Safety Data Sheet (MSDS) for all cleaning solutions used in the surface preparation of steel components. Highlight VOC limits and chemical component limits.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

F. Evaluation Reports: For steel deck.

1.6 QUALITY ASSURANCE

A. Except as modified by governing codes and by this specification, comply with the applicable provisions and recommendations of the following codes and standards:

1. New York State Building Code, Latest Edition
2. American Iron and Steel Institute (AISI) "Specification for the Design of Cold-Formed Steel Structural Members".
3. American Welding Society (AWS), D1.1 "Structural Welding Code" and D1.3 "Structural Welding Code-Sheet Steel".
4. Steel Deck Institute (SDI) "Design Manual for Composite Decks, Form Decks, and Roof Decks".
5. American National Standards Institute (ANSI)/Steel Deck Institute (SDI) “Quality Control and Quality Assurance for Installation of Steel Deck”.
6. ASTM Standards as applicable in the building code of the local jurisdiction and as noted in this specification.

B. Fabricator Qualifications: The work under this section shall be performed by a fabricator and erector submitting conclusive evidence of having satisfactorily completed work of similar scope and of having the necessary skill, equipment, facilities and capacities to fabricate and perform the erection in accordance with the construction schedules and in full compliance with all requirements of the Contract Documents.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work. However, efforts should be made to minimize the disturbance to site and soil conditions for example, by not requiring excessive areas to be put aside for on-site storage.

B. Store materials to permit easy access for inspection and identification. Keep all materials in a safe, dry, off ground location, using pallets, platforms, or other supports. Protect all materials from corrosion and deterioration, discoloration or staining. Make efforts to minimize any wastage and ensure that as much waste as possible is recycled.

C. Do not store materials on structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Examine all work prepared by others to receive work of this section and report any defects affecting installation to the contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

B. If the supporting beams are not properly aligned or sufficiently level to permit proper bearing of the steel decking units, the steel decking contractor shall bring the matter to the attention of the contractor for corrective action. The steel decking units are not to be placed until the necessary correlations are made.

C. Installation of the deck and shear studs will be inspected by the Architect and/or Owner's agent.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 MANUFACTURERS

A. Supply manufactured deck units in accordance with the applicable requirements of the Steel Deck Institute's "Design Manual for Floor Decks and Roof Decks".

B. Deck shall be manufactured by one of the following (or other equivalent as approved by the architect and engineer of record):

1. United Steel Deck (manufactured by Canam)
2. New Millennium
3. Vulcraft

2.3 DECK MATERIALS

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, with the minimum section properties indicated on the drawings. Contractor shall provide heavier gauge if minimum gauge indicated is not adequate to support total loads as shown on the drawings.

B. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, with the minimum section properties indicated on the drawings. Contractor shall provide heavier gauge if minimum gauge indicated is not adequate to support total loads as shown on the drawings.

C. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated on the drawings. Contractor shall provide heavier gauge if the minimum gauge indicated is not sufficient to support construction loads as unshored forms and/or total load as indicated on the drawings based on the composite section. Deck shall have deformations specifically designed to produce composite action between the deck and the concrete slab by mechanical bond.

D. Non-composite Form Deck: Fabricate ribbed-steel sheet non-composite form-deck panels to comply with "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated on the drawings. Contractor shall provide heavier gauge if minimum gauge indicated is not adequate to support total loads as shown on the drawings.

2.4 ACCESSORIES

A. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

B. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

C. Anchor clips, vent clips, welding washers, flashing, saddle plates, sump pans, other accessories shall be those types, sizes, and configurations recommended by the decking manufacturer, and shall be of the same material and finish as the deck units. All accessories shall conform to ASTM A653/A63M.

D. Cell closure flexible strips, and fillers shall be of material in compliance with applicable building code governing class of construction.

E. Provide metal closure strips at edges of all slabs and openings that serve as pour stops for concrete. Gauge shall be sufficient to span or cantilever from steel beams.

F. Roof sump pans: Fabricate from a single piece of galvanized sheet steel of the same quality as the deck units; not less than nominal 0.0747" (14 gauge) thick before galvanizing; with bottoms level after erection and sloping sides to direct water flow to the drain, unless otherwise shown. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 3" wide. Recess pans not less than 1-1/2" below the roof deck surface, unless otherwise shown or required by deck configuration. Weld to deck at maximum 12" on-center.

G. Headed studs for shear connectors shall be per drawings manufactured from cold drawn wire and conforming to ASTM A 108, Grades 1010 thru 1020.

1. Subject to compliance with requirements, studs shall be manufactured by one of the following:

a. Nelson
b. KSM

H. Paint: Where indicated on drawings, must be compatible with galvanized surfaces such that minimal preparation is required.

1. For decks exposed to exterior conditions or high humidity paint must

a. Demonstrate corrosion resistance per standards ASTM B 117 & ASTM D 5894

2. For all decks paint must

a. Demonstrate a minimum opacity as determined by ASTM D 2805
b. Demonstrate a minimum of adhesion as classified by 4B of ASTM D 3359 method A

3. The product shall not contain any of the prohibited compounds as listed in Green Seal *Standard for Paintings and Coatings*, GS-11, latest edition and in Master Painters Institute (MPI) *Green Performance Standard*, GPS-

1-08.

4. The product shall meet the VOC limits as set forth in the MPI Green Performance Standard, GPS-1-08, with a maximum allowable VOC of 340 g/L for rust preventative coatings. Limits are expressed in THINNED state. Preference shall be given to products with the least crystalline silica content.

2.5 FABRICATION

A. Fabricate deck units in accordance with the AISI's "Specification for the Design of Cold-Formed Steel Structural Members" and accepted shop drawings. Fabricate deck units to the sizes and configurations indicated and cut to lengths which will span not fewer than three supporting members; use only full length units at overhang where indicated in a manner that laps fit tightly. Locate openings for penetrations where indicated and provide support framing and edge reinforcement for all openings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSPECTION

A. Inspection of the metal deck and shear stud installation will be performed by an inspection agency retained by the owner at no expense to the contractor. The inspection agency shall work under the direction of the owner. Contractor shall provide the inspection agency with the following:

1. Schedule of all work in both shop and field with at least ten days written notice before commencement of either activity.
2. A complete set of approved shop and erection drawings.

3.3 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section. Erection shall closely follow the erection of structural steel.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members as per load schedule provided on contract documents.

D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work, per drawings and manufacturer’s specifications.

F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

G. Headed shear studs shall be installed by welding through metal deck onto beam below. Automatic welding machinery of approved design, amperage, duration of current, etc., shall be used. Studs shall be tested by testing laboratory in accordance with AWS Procedures for Bend Test; replace all studs which do not pass test.

H. All welding shall be performed by competent experienced welding mechanics. Welding mechanics must have AWS D1.3 certification for welding sheet metal less than 1/8 inch thick. All welds shall be given a protective coat of paint as specified in painting article of section 051200.

I. All abraded or damaged protective surfaces of steel decking work shall be touched up with a protective coat of paint by this contractor as erected.

3.4 ROOF DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members per drawings.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports per drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing per manufacturer’s specification but not less than 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

D. All unframed openings in roof deck shall be reinforced per the drawings.

E. Roof sump pans: Fabricate from a single piece of galvanized sheet steel of the same quality as the deck units; not less than nominal 0.0747" (14 gauge) thick before galvanizing; with bottoms level after erection and sloping sides to direct water flow to the drain, unless otherwise shown. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 3" wide. Recess pans not less than 1-1/2" below the roof deck surface, unless otherwise shown or required by deck configuration. Weld to deck at maximum 12" on-center.

F. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.5 FLOOR DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members per the drawings.Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports per the drawings.

B. End Bearing: Install deck ends over supporting frame with a minimum end bearing per manufacturer’s specification but not less than 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2” minimum or butted at Contractor's option.

C. All unframed deck openings in composite deck with concrete larger than 6" shall be reinforced per the drawings.

D. At composite deck with concrete, metal hanger tabs shall be installed at all panel sidelaps 24 inches on-center, longitudinally 24 inches on-center to create a grid nominally 24 inches by 24 inches. Tabs shall be 18 gauge minimum, capable of supporting the specified ceiling, tabs shall be a minimum of 18 gauge capable of supporting ceiling and all other suspended loads or 200 pounds, whichever is greater.

E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

F. Sealing cellular deck openings, butt joints, and junctions with trench headers with tape is not included in this Section. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

G. The steel decking units shall be placed on the supporting steel framework and adjusted to final position before being permanently fastened. Each unit shall be brought to proper bearing on the supporting beams.

H. Deck shall, where possible, span 3 or more supports.

I. The side laps of adjacent units shall be fastened by approved method (to be shown on shop drawings) between supports at intervals as noted on the drawings.

J. All welding shall be performed by competent experienced welding mechanics. Welding mechanics must have AWS D1.3 certification for welding sheet metal less than 1/8 inch thick. All welds, shall be given a protective coat of paint as specified in painting article of Section 051200.

K. All abraded or damaged protective surfaces of steel decking work shall be touched up with a protective coat of paint by this contractor as erected.

L. Headed shear studs shall be installed by welding through metal deck onto beam below. Automatic welding machinery of approved design, amperage, duration of current, etc., shall be used. Studs shall be tested by testing laboratory in accordance with AWS Procedures for Bend Test; replace all studs which do not pass test.

M. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.6 FIELD QUALITY CONTROL

A. Special Inspection as required by the applicable Building Code of all metal decking will be performed by an inspection agency retained by the Owner at no expense to the Contractor. The inspection agency shall work under the direction of the owner. Contractor shall provide the inspection agency with the following:

1. Schedule of all work in field with at least ten days' written notice before commencement of either activity.
2. A complete set of approved shop and erection drawings.
3. Order sheets, material bills, shipping bills and mill test reports.
4. Representative sample pieces as requested by the testing agency.
5. Full and ample means and assistance for testing all material.
6. Proper facilities, including scaffolding, temporary work platforms, etc., for inspection of the work in the mills, shop and field.

B. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the inspector can refer back to the person making the connection.

C. The following minimum criteria shall be adhered to in testing of welds:

1. All welds shall be examined by visual means.
2. 25% of all welds, selected randomly, shall be measured.
3. In addition, all welds subject to tensile stress shall be examined by the Ultrasonic Method for 100% of their length.
4. 10% of all manual fillet welds shall be tested by the magnetic particle method.
5. 1'-0" at each end of automatic fillet welds shall be tested by the magnetic particle method.
6. 100% of groove welds shall be tested by the ultrasonic method.

D. Field inspection will include examination of decking for welding and touching-up of shop coat.

E. Inspection of welding will be such as to assure that the work is within the quality requirements specified below and elsewhere in this section of the specifications and will include:

1. Ascertainment that the electrodes and flux used for the SAW, GMAW and FCAW welding processes conform to the requirements of this section of the specifications.
2. Ascertainment that the approved welding procedures and sequence are followed without deviation, unless specific approval for change is obtained from the architect.
3. The testing agency shall be prepared to utilize the following approved methods of testing:

    a. Liquid penetrant inspection: ASTM E 165.
    b. Magnetic particle: ASTM A 709.
    c. Radiographic inspection: ASTM E 94 and E 1032.
    d. Ultrasonic inspection: ASTM E 114 and AWS, Chapter 6, Section C.

F. When defects are revealed, additional inspection by whatever method is deemed necessary by the inspector, shall be performed to the extent necessary to assure that the full amount of defect has been located. No further work shall be done on the assembly or sub-assembly in question until all the necessary corrections have been made. Defects shall be repaired, using the same welding procedure that was used initially in making the weld, unless otherwise approved by the architect. Inspection of the repaired weld shall be by the same method that was used to reveal the defect. A second repair of a defective area shall not be made without approval of the Architect.

G. A distinguishing mark will be placed on all work that has been inspected and approved. Material or work that is not acceptable will be designated by words such as "REJECT" or "REPAIR" marked directly on the material or work.

H. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

I. Remove and replace work that does not comply with specified requirements.

J. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.7 CLEANING UP

A. Remove all equipment, unused materials and debris from the site immediately upon the completion of this work.

3.8 WASTE MANAGEMENT

A. Separate and recycle waste materials to the maximum extent feasible.

B. Separate for recycling and place in designated containers the following metal waste in accordance with the Waste Management Plans and local recycler standards: Steel, iron, galvanized steel, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass and bronze.

C. Collect all metal cut-offs and scraps and recycle as above.

D. Fold up metal banding, flatten and place in designated area.

E. Close and seal tightly all partly used paint and finish containers and store protected in a well-ventilated, fire-safe area at moderate temperature.

F. Designated un-used paint for:

1. Immediate re-use
2. Long term maintenance needs
3. Recycling by an appropriate facility.
4. Donation

G. Place empty containers of solvent-based paints in areas designated for hazardous materials.

H. Do not dispose of paints or solvents by pouring on the ground. Place amounts too small to re-use in designated containers for proper disposal

I. Place materials defined as hazardous or toxic waste in designated containers.

END OF SECTION

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the cold-formed metal framing as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. "C" shaped steel studs for exterior non-load bearing wall frame construction.
2. "C" shaped steel joists.
3. Anchors and accessories.
4. Gypsum sheathing.
5. Field inspection.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Structural Steel - Section 051200.

C. Thermal Insulation - Section 072100.

D. Vapor permeable air barrier - Section 072700.

E. Interior steel stud construction - Section 092900.

1.4 QUALITY ASSURANCE

A. Component Design: Compute structural properties of studs in accordance with AISI "North American Specification for the Design of Cold Formed Steel Structural Members."

B. Fire-Rated Assemblies: Where framing units are indicated to be components of fire-resistance rated assemblies, provide cold formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction. Products used in the assembly shall carry a classification label from an approved testing and inspection agency.

C. Qualifications

1. Manufacturer's Qualifications: Minimum five years' experience in producing products of the type specified.

2. Installer's Qualifications: Minimum three years' experience in installation of the type of product specified.

3. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M "Structural Welding Code - Steel" and AWS DL3 "Structural Welding Code – Sheet Steel."

D. Pre-Installation Meeting

1. Convene meeting at project site within one week of scheduled start of installation with representatives of the following in attendance: Owner, Architect, General Contractor, and metal framing subcontractor.

2. Review substrate conditions, requirements of related work, installation instructions, storage and handling procedures, and protection measures.

3. Keep minutes of meeting, including responsibilities of various parties and deviations from specifications and installation instructions. Distribute minutes to attendees within 72 hours.

E. Comply with the following standards:

1. American Iron and Steel Institute (AISI):

a. "North American Specification for the Design of Cold-Formed Steel Structural Members," latest edition.
b. "Standard for Cold-Formed Steel Framing General Provisions."

2. American Welding Society (AWS):

a. Structural Welding Code (D1.1).
b. Specifications for Welding Sheet Steel in Structures (E1.3).

3. ASTM:

a. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coted (Galvannealed) by the Hot-Dip Process.
b. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
c. ASTM A 924 - Standard Requirements for Sheet Steel, Metallic-Coated by the Hot-Dipped Process.
d. ASTM C 955 – Standard Specification for Cold-Formed Structural Framing Members.
e. ASTM A 1003 - Standard Specification for Steel Sheet, Carbon, Metallic- and Non-Metallic-Coated for Cold-Formed Framing Members.
f. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
g. ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

F. Vertical and Lateral Fire Propagation Test Characteristics: The exterior wall assembly is required to comply with NFPA 285 "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components." The base wall, stud cavity insulation, wall sheathing, air barrier, continuous wall rigid insulation and exterior cladding are components that are required to be to be evaluated as part of this specific assembly test. The basis of design product listed herein is a component of the design test assembly selected by the Architect.

1.5 SUBMITTALS

A. Product Data: For information only, submit copies of manufacturer's product information and installation instructions for each item of cold-formed framing and accessories.

B. Shop Drawings

1. Submit shop drawings for special components and installations not fully dimensioned or detailed in manufacturer's product data. Include placing drawings for framing members showing size and gauge designations, number, type, location and spacing. Indicate supplemental bracing, splices, window and door headers accessories and details as may be required for proper installation.

2. If the Contractor elects to prefabricate framing members into panels for erection, he shall submit shop drawings of such panels at suitable scale showing all dimensions, components, and methods of fastening and support.

C. For fasteners, submit product data sheet and samples.

D. Engineering Data

1. Submit Engineering Data drawings to the Architect for review. The Contractor is responsible for the structural design and supports for the cold-formed metal frame, and must show his proposed system and how the Performance Criteria noted below is accommodated on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

E. Quality Assurance Submittals: Submit the following:

1. Qualifications: Proof of manufacturer and installer qualifications.

a. Member in good standing of the Steel Framing Industry Association (SFIA) or be a part of a similar organization that provides verifiable code compliance.
b. Products to be certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.

2. Structural design calculations.

3. Certificates

a. Submit mill certificates by framing member/accessory manufacturer certifying compliance with material requirements.
b. Welder certificates.

4. Manufacturer's installation instructions for framing members and framing accessories.

1.6 PERFORMANCE CRITERIA

A. Cold-formed metal framing system shall be designed, fabricated, and installed to withstand a 30 psf suction and pressure load (or greater if required by Code) with a maximum deflection of L/720 with masonry.

B. Cold Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100 and AISI S200 and ASTM C955, Section 8.

1. NOTE: Per New York State Building Code 2015, ASTM C955, Section 8, screw-penetration test, applies only to studs and tracks; otherwise only AISI S200 applies.

C. Design system to accommodate vertical deflection of structural building frame, live loading, seasonal and day/night temperature ranges and construction tolerances.

D. Comply with prevailing New York State Building Code 2015 requirements for seismic connections and loads.

1.7 PRODUCT DELIVERY AND STORAGE

A. Protect metal framing units from rusting and damage. Deliver to one project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type and grade. Store off the ground in a dry ventilated space or protect with suitable waterproof coverings. Conform to storage and handling requirements of AISI "Code of Standard Practice."

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Provide cold-formed steel framing manufactured by Marino/Ware, Superior Steel Studs, Clark Dietrich Building Systems, Super Stud Building Products, or approved equal.

2.2 METAL FRAMING: GENERAL

A. System Components: With each type of metal framing required, provide manufacturer's standard steel runners, (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners and accessories, as recommended by manufacturer for the applications indicated, as needed to provide a complete metal framing system.

2.3 MATERIALS

A. Steel Sheet for Studs and Tracks: ASTM A 1003 Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.

2. Coating: G90 galvanized coating.

B. Steel Sheet for Clips: ASTM A 653, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.

2. Coating G90 galvanized coating.

2.4 FRAMING MEMBERS

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges; thickness and grade as required by structural performance.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths compatible with studs, un-punched, with un-stiffened flanges; thickness and grade as required by structural performance.

2.5 FRAMING ACCESSORIES

A. Stamp manufacturer's name on each accessory item.

B. Provide screws with accessories designated for screw attachment.

C. Connector Devices

1. Vertical Deflection Clips: "VertiClip," including step bushings, as manufactured by The Steel Network Inc. (919) 845-1025 or approved equal. Rigid attachments to structure and screw attachment to stud web using step-bushings to permit frictionless vertical movement. 68 mils minimum thickness, size as required by structural design calculations.

2. Rigid Clip Angles: "StiffClip" as manufactured by The Steel Network Inc., or approved equal, size as required by structural design calculations. Rigid attachment to structure and stud web.

D. Bridging

1. Cold Rolled Channel: 1-1/2" by ½" by 56 mil thick.

a. Bridging Clip: "BridgeClip" as manufactured by The Steel Network Inc. or approved equal. Provide attachment through stud punch-out clamping onto stud web and wrapping around bridging channel. Provide holes for screw attachment to stud web and channel.

2. Flat Strap: Width and thickness as required by structural design calculations. Rigid attachment to stud flange.

3. Solid Bridging: Channel shaped bridging with lipped flanges and integral formed clips. Screw attachment to stud. 33 mils minimum thickness, size as required by structural design calculations.

4. Bridging and accessories shall be hot dip zinc coated per ASTM A 153.

E. Optional Header for Window and Door Openings: At Contractor's option, provide "ProX Header" system made by Brady Innovations LLC, or approved equal complete with all accessories including clips and accessories; finish and gauge to match studs.

2.6 FASTENERS

A. Screws: Corrosion resistant coated, self-drilling, pan or hex washer head. Provide screw type and size as required by structural design calculations.

B. Anchor Bolts and Studs: ASTM A 307, Grade A, carbon steel, with hex-head carbon steel nuts and flat steel washers. Hot-dip zinc coated in accordance with ASTM A 153. Provide bolt or stud type and size as required by structural design calculations.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

2.7 GALVANIZING TOUCH-UP

A. For touching up damaged galvanized surfaces after erection, provide "Silver Galv" made by Z.R.C. Worldwide. Apply to a dry film thickness of 1.5 to 3.0 mils.

2.8 GYPSUM SHEATHING AND RELATED ACCESSORIES

A. Gypsum Sheathing: 1/2" thick "Dens-Glass" made by Georgia Pacific, "Securock Glass-Mat Sheathing" made by U.S. Gypsum Co., "Gold Bond EXP Extended Exposure Sheathing" made by National Gypsum Co., "Weather Defense" made by Lafarge/Continental, or approved equal, meeting ASTM C 1177.

B. Fasteners: 1-1/4" Type S-12 screws "Climaseal" finish.

C. Joint Treatment: Provide a one-part high performance sealant conforming to ASTM C 920, Type S, Grade NS, Class 25 meeting with the approval of the air/vapor barrier manufacturer for compatibility; see Section 072700 for description. Apply a 3/8" bead of sealant to the joint and trowel flat. Apply enough of the same material to each fastener to cover completely when trowelled flat.

2.9 FABRICATION

A. Framing components may be prefabricated into panels prior to erection. Fabricate panels plumb, square, true to line and braced against racking with joints welded. Perform lifting of prefabricated panels in a manner to prevent damage or distortion in any members in the assembly.

B. Fastenings: Attach similar components by welding. Attach dissimilar components by welding, bolting or screw fasteners, as standard with manufacturer.

C. Wire tying of framing components is not permitted.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where cold-formed metal framing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION: GENERAL

A. Methods of construction shall be piece by piece.

B. Connections shall be accomplished with self-drilling screws or welding so that the connection meets or exceeds the design loads required at that connection.

C. Studs shall be installed seated squarely (within 1/16") against the web portion of the top and bottom tracks. Tracks shall rest on a continuous, uniform bearing surface.

D. Cutting of steel framing members may be accomplished with a saw or shear. Torch cutting of loaded members is not permitted. Cutting of loaded members is not permitted unless under supervision of the project architect or engineer.

E. Temporary bracing shall be provided and left in place until work is permanently stabilized.

F. Bridging shall be of size and type shown on the approved shop drawings and as called for in the engineering calculations.

G. Install headers in all openings that are larger than the stud spacing in that wall. Form headers as shown on the drawings.

H. Insulation meeting the requirements of Section 072100 shall be placed in all jamb and header type conditions that will be inaccessible after their installation into the wall.

I. Provide jack studs to support each end of headers. These studs shall be securely connected to the header and must seat squarely in the lower track of the wall, and be properly attached to it.

J. If, by design, a header is low in the wall, the less than full-height studs (cripples) that occur over the header shall be designed to carry all imposed loads.

K. Wall track shall not be used support any load unless specifically designed for that purpose.

L. All axially loaded members shall be aligned vertically, to allow for full transfer of the loads down to the foundation. Vertical alignment shall be maintained at floor/wall intersections or alternate provisions for load transfer may be made.

M. Holes that are field cut into steel framing members shall be within the limitation of the product and its design. Provide reinforcement where holes are cut through load bearing members in accordance with manufacturer's recommendations and as approved by the Architect or Engineer.

N. Touch up all steel bared by welding using touch-up coating specified herein.

O. Studs shall be spaced to suit the design requirements and limitations of collateral facing materials.

P. Care should be taken to allow for additional studs at intersections, corners, doors, windows, control joints, etc., and as called for in the shop drawings or design calculations.

Q. Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer’s recommendations and industry standards in each case, considering weight or loading resulting from item supported.

R. Provide for structure movement, expansion shall be allowed where indicated and necessary by design or code requirements.

S. Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

T. Install horizontal bridging in stud system, spaced (vertical distance) at not more than 48 inches on center. Fasten at each intersection.

U. Splicing of axially loaded members or floor joists shall not be permitted.

V. Wire tying of members is not permitted.

3.3 INSTALLATION OF GYPSUM SHEATHING

A. Fasten sheathing to exterior of each stud with specified fasteners spaced 3/8" from ends and edges and approx. 8" o.c. at each stud. Install fasteners in accordance with manufacturer’s recommendations using 2500-RPM maximum screw gun. Sheathing board shall be installed horizontally. Apply sealant between joints and trowel flush; and apply sealant around sheathing perimeter and at interface with other materials. Cover fastener heads with sealant and trowel flush.

B. Refer to Section 072700 for vapor permeable air barrier description.

END OF SECTION

SECTION 055000

MISCELLANEOUS METALS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the miscellaneous metal work as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Rough hardware.
2. Vertical steel ladders.
3. Steel pipe handrails and railings not part of steel pan stair assemblies.
4. Loose steel lintels.
5. Loose bearing and leveling plates.
6. Light steel framing and supports not included as part of work of other trades.
7. Miscellaneous steel trim.
8. Shelf and relieving angles.
9. Countertop supports.
10. Masonry support steel.
11. Sleeves in concrete walls and slabs.
12. Steel framing, bracing, supports, anchors, bolts, shims, fastenings, and all other supplementary parts indicated on drawings or as required to complete each item of work of this Section.
13. Prime painting, touch-up painting, galvanizing and separation of dissimilar metals for work of this Section.
14. Cutting, fitting, drilling and tapping work of this Section to accommodate work of other Sections and of concrete, masonry or other materials as required for attaching and installing work of this Section.

1.3 RELATED SECTIONS

A. Structural Steel - Section 051200.

B. Steel Pan Stairs - Section 055113.

C. Painting and Finishing - Section 099000.

1.4 QUALITY ASSURANCE

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

C. Reference Standards: The work is subject to requirements of applicable portions of the following standards:

1. "Manual of Steel Construction," American Institute of Steel Construction.

2. AWS D1-1 "Structural Welding Code," American Welding Society.

3. SSPC SP-3 "Surface Preparation Specification No. 3, Power Tool Cleaning," Steel Structures Painting Council.

4. SSPC PA-1 "Painting Application Specification," Steel Structures Painting Council.

5. "Handbook on Bolt, Nut and Rivet Standards," Industrial Fasteners Institute.

D. Steel Materials: For steel to be hot dip-galvanized, provide steel chemically suitable for metal coatings complying with the following requirements: carbon below 0.25 percent, silicon below 0.24 percent, phosphorous below 0.05 percent, and manganese below 1.35 percent. Notify galvanizer if steel does not comply with these requirements to determine suitability for processing.

E. Engage the services of a galvanizer who has demonstrated a minimum of five (5) years' experience in the successful performance of the processes outlined in this specification in the facility where the work is to be done and who will apply the galvanizing and coatings within the same facility as outlined herein. The Architect has the right to inspect and approve or reject the galvanizer/galvanizing facility.

F. The galvanizer/galvanizing facility must have an ongoing Quality Control/Quality Assurance program which has been in effect for a minimum of five years and shall provide the Architect with process and final inspection documentation. The galvanizer/galvanizing facility must have an on-premise testing facility capable of measuring the chemical and metallurgical composition of the galvanizing bath and pickling tanks.

G. Inspection and testing of hot-dip galvanized coating shall be done under the guidelines provided in the American Hot-Dip Galvanizers Association (AGA) publication "Inspection of Products Hot-Dip Galvanized After Fabrication."

1.5 PERFORMANCE STANDARDS

A. Railings shall be designed to resist loads per New York State Building Code 2015.

1.6 SUBMITTALS

A. Manufacturer's Literature: Submit manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions for products to be used in the fabrication of miscellaneous metal work, including paint products.

B. Shop Drawings: Shop drawings for the fabrication and erection of all assemblies of miscellaneous iron work which are not completely shown by manufacturer's data sheets. Include plans and elevations at not less than 1" to 1'-0" scale and include details of sections and connections at not less than 3" to 1'-0" scale. Show anchorage and accessory items.

C. Engineering Data

1. Before any ladders or railings are fabricated, submit engineering data drawings to the Architect for review indicating how performance standards specified here shall be met. The Contractor is responsible for the structural design and supports for these systems and must show his proposed systems on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

D. Welding shall be indicated on shop drawings using AWS symbols and showing length, size and spacing (if not continuous). Auxiliary views shall be shown to clarify all welding. Notes such as 1/4" weld, weld and tack weld are not acceptable.

E. Certification: For items to be hot-dip galvanized, identify each item galvanized and to show compliance of application. The Certificate shall be signed by the galvanizer and shall contain a detailed description of the material processed and the ASTM standard used for the coating and, the weight of the coating. In addition, and as attachment to Certification, submit reports of testing and inspections indicating compliance with the provisions of this Section.

PART 2 PRODUCTS

2.1 MATERIALS

A. Metals

1. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.

2. Steel Plates, Shapes and Bars: ASTM A 36.

3. Steel Bar Grating: ASTM A 1011 or ASTM A 36.

4. Steel Tubing: Cold formed, ASTM A 500; or hot rolled, ASTM A 501.

5. Structural Steel Sheet: Hot rolled, ASTM A 1011; or cold rolled, ASTM A 1008, Class 1; of grade required for design loading.

6. Galvanized Structural Steel Sheet: ASTM A 924, of grade required for design loading. Coating designation G90.

7. Steel Pipe: ASTM A 53, type and grade as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (Schedule 40), unless otherwise indicated.

8. Gray Iron Castings: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.

9. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.

10. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

11. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

B. Grout: Non-shrink, non-metallic grout conforming to the requirements of Section 033000.

C. Fasteners

1. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.

2. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

3. Anchor Bolts: ASTM F 1554, Grade 36.

4. Lag Bolts: ASME B18.2.1.

5. Machine Screws: ASME B18.6.3.

6. Plain Washers: Round, carbon steel, ASME B18.22.1.

7. Masonry Anchorage Devices: Expansion shields, FS FF-S-325.

8. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required.

9. Lock Washers: Helical spring type carbon steel, ASME B18.21.1.

D. Shop Paint: Shop prime all non-galvanized miscellaneous metal items using Series 88 Azeron Primer made by Tnemec, ICI Devoe "Rust Guard" quick dry alkyd shop coat No. 41403, or "Interlac 393" by International Protection Coatings.

1. If steel is to receive high performance coating as noted in Section 099000, shop prime using primer noted in Section 099000.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Galvanizing Repair Coating: For touching up galvanized surfaces after erection, provide repair coating that is V.O.C. compliant, equal to "Silver Galv" made by Z.R.C. Worldwide or approved equal. Apply to a dry film thickness of 1.5 to 3.0 mils.

2.2 PRIME PAINTING

A. Scope: All ferrous metal (except galvanized steel) shall be cleaned and shop painted with one coat of specified ferrous metal primer. No shop prime paint required on galvanized steel or aluminum work.

B. Cleaning: Conform to Steel Structures Painting Council Surface Preparation Specification SP 3 (latest edition) "Power Tool Cleaning" for cleaning of ferrous metals which are to receive shop prime coat.

1. Steel to get high performance coating as noted in Section 099000 shall be cleaned as per SSPC SP.6 "Commercial Blast Cleaning."

C. Application

1. Apply shop prime coat immediately after cleaning metal. Apply paint in dry weather or under cover. Metal surfaces shall be free from frost or moisture when painted. Paint all metal surfaces including edges, joints, holes, corners, etc.

2. Paint surfaces which will be concealed after shop assembly prior to such assembly. Apply paint in accordance with approved paint manufacturer's printed instructions, and the use of any thinners, adulterants or admixtures shall be only as stated in said instructions.

3. Paint shall uniformly and completely cover the metal surfaces, 2.0 mils minimum dry film thickness. No work shall be shipped until the shop prime coat thereon has dried.

D. Touch-Up: In the shop, after assembly and in the field, after installation of work of this Section, touch-up damaged or abraded portions of shop prime paint with specified ferrous metal primer.

E. Apply one shop coat to fabricated metal items, except apply two (2) coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

2.3 GALVANIZING

A. Scope: All ferrous metal exposed to the weather, and all ferrous metals indicated on drawings or in specifications to be galvanized, shall be cleaned and then hot-dipped galvanized after fabrication as provided by Duncan Galvanizing or approved equal.

B. Avoid fabrication techniques that could cause distortion or embrittlement of steel items to be hot-dip galvanized. Fabricator shall consult with hot-dip galvanizer regarding potential warpage problems or handling problems during the galvanizing process that may require adjustment of fabrication techniques or design before finalizing shop drawings and beginning of fabrication.

C. Cleaning: Thoroughly clean metal surfaces of all mill scale, rust, dirt, grease, oil, moisture and other contaminants prior to galvanizing.

D. Application: Hot-dip galvanizing shall conform to the following:

1. ASTM A 143: Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel.

2. ASTM A 123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A 153: Galvanized Coating on Iron and Steel Hardware - Table 1.

4. ASTM A 384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.

5. ASTM A 385: Practice for Providing High Quality Zinc Coatings.

6. ASTM A 924: Galvanized Coating on Steel Sheets.

7. Minimum weight of galvanized coating shall be two (2) oz. per square foot of surface.

E. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

F. All galvanized materials must be inspected for compliance with these specifications and marked with a stamp indicating the name of the galvanizer, the weight of the coating, and the appropriate ASTM number.

G. To minimize surface imperfection (e.g.: flux inclusions), material to be galvanized shall be dipped into a solution of Zinc Ammonium Chloride (pre-flux) immediately prior to galvanizing. The type of galvanizing process utilizing a flux blanket overlaying the molten zinc will not be permitted.

H. After galvanizing all materials not exposed to view must be chromated by dipping material in a 0.2% chromic acid solution.

I. Galvanized surfaces, where exposed to view, must have a smooth, level surface finish. Where this does not occur, piece shall be rejected and replaced to the acceptance of the Architect.

2.4 PROTECTIVE COATINGS

A. Whenever dissimilar metals will be in contact, separate contact surfaces by coating each contact surface prior to assembly or installation with one coat of specified bituminous paint, which shall be in addition to the specified shop prime paint. Mask off those surfaces not required to receive protective coating.

2.5 WORKMANSHIP

A. General

1. Miscellaneous metal work shall be fabricated by an experienced fabricator or manufacturer and installed by an experienced tradesman.

2. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and erection shall be in accordance with drawings and specifications, approved shop drawings, and best practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected.

3. All work shall be accurately and neatly fabricated, assembled and erected.

B. Shop Assembly: Insofar as practicable, fitting and assembly of work shall be done in shop. Shop assemble work in largest practical sizes to minimize field work. It is the responsibility of the miscellaneous metal subcontractor to assure himself that the shop-fabricated miscellaneous metal items will properly fit the field condition. In the event that shop-fabricated miscellaneous metal items do not fit the field condition, the item shall be returned to the shop for correction.

C. Cutting: Cut metal by sawing, shearing, or blanking. Flame cutting will be permitted only if cut edges are ground back to clean, smooth edges. Make cuts accurate, clean, sharp and free of burrs, without deforming adjacent surfaces or metals.

D. Holes: Drill or cleanly punch holes; do not burn.

E. Connections: Make connections with tight joints, capable of developing full strength of member, flush unless indicated otherwise, formed to exclude water where exposed to weather. Locate joints where least conspicuous. Unless indicated otherwise, weld or bolt shop connections; bolt or screw field connections. Provide expansion and contraction joints to allow for thermal movement of metal at locations and by methods approved by Architect.

1. Welding

a. Shall be in accordance with AWS D1.1 Structural Welding Code of the American Welding Society and shall be done with electrodes and/or methods recommended by the manufacturer of the metals being welded.
b. Welds shall be continuous, except where spot welding is specifically permitted. Welds exposed to view shall be ground flush and dressed smooth with and to match finish of adjoining surfaces; undercut metal edges where welds are required to be flush.
c. All welds on or behind surfaces which will be exposed to view shall be done so as to prevent distortion of finished surface. Remove weld spatter and welding oxides from all welded surfaces.

2. Bolts and Screws: Make threaded connections tight with threads entirely concealed. Use lock nuts. Bolts and screw heads exposed to view shall be flat and countersunk. Cut off projecting ends of exposed bolts and screws flush with nuts or adjacent metal.

F. Operating Mechanism: Operating devices (i.e. pivots, hinges, etc.) mechanism and hardware used in connection with this work shall be fabricated, assembled, installed and adjusted after installation so that they will operate smoothly, freely, noiselessly and without excessive friction.

G. Built-In Work: Furnish anchor bolts, inserts, plates and any other anchorage devices, and all other items specified under this Section of the Specifications to be built into concrete, masonry or work of other trades, with necessary templates and instructions, and in ample time to facilitate proper placing and installation.

H. Supplementary Parts: Provide as necessary to complete each item of work, even though such supplementary parts are not shown or specified.

I. Coordination: Accurately cut, fit, drill and tap work of this Section to accommodate and fit work of other trades. Furnish or obtain, as applicable, templates and drawings to or from applicable trades for proper coordination of this work.

J. Exposed Work

1. In addition to requirements specified herein and shown on drawings, all surfaces exposed to view shall be clean and free from dirt, stains, grease, scratches, distortions, waves, dents, buckles, tool marks, burrs, and other defects which mar appearance of finished work.

2. Metal work exposed to view shall be straight and true to line or curve, smooth arrises and angles as sharp as practicable, miters formed in true alignment, profiles accurately intersecting, and with joints carefully matched to produce continuity of line and design.

3. Exposed fastenings, where permitted, shall be of the same material, color and finish as the metal to which applied, unless otherwise indicated, and shall be of the smallest practicable size.

K. Preparation for Hot-Dip Galvanizing: Fabricator shall correctly prepare assemblies for galvanizing in consultation with galvanizer and in accordance with applicable Reference Standards and applicable AGA publications for the "Design of Products to be Hot-Dip galvanized After Fabrication." Preparation shall include but not be limited to the following:

1. Remove welding flux.

2. Drill appropriate vent holes and provide for drainage in inconspicuous locations of hollow sections and semi-enclosed elements. After galvanizing, plug vent holes with shaped lead and grind smooth.

2.6 MISCELLANEOUS METALS ITEMS

A. Rough Hardware

1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.

2. Fabricate items to sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood connections; elsewhere, furnish steel washers.

B. Ladders: Vertical steel ladders shall be eighteen (18) inches wide with 3/4" diameter non-slip steel rungs spaced twelve (12) inches o.c. Stringers shall be 3/8" thick by 2-1/2" wide steel bars; rungs welded to bars. Attach ladders to walls six (6) inches from top and bottom and maximum thirty-six (36) inches o.c. from these points. At the roof, gooseneck the rails back to the structure to provide secure ladder access.

1. Ladders shall be fabricated to support a live load of one hundred (100) lbs. per square foot and a concentrated load of three hundred (300) lbs. per rung; loads not to act simultaneously.

C. Steel Pipe Handrails: Provide Schedule 40 steel pipe of size shown on Drawings. Fittings shall be flush type, malleable of cast iron. Brackets shall be malleable iron, design as selected by the Architect.

1. Construction: Form direction changes in rails using solid bar stock or elbows. Connections shall be shop welded and ground smooth and flush, except where field connections and expansion joints are required. Field connections may be welded, internal sleeve and plug weld, or internal sleeve and set screw.

2. Secure handrails to walls with wall brackets. Provide brackets of malleable iron castings, with not more than three (3) inches clearance from inside face of handrail to wall surface. Neatly drill wall plate portion of the bracket into concrete or masonry to receive bolts for concealed anchorage. For installation at drywall, Drywall trades shall provide plate to receive wall plate portion of bracket and anchor or bolt wall plate through drywall to supporting steel plate. Locate brackets at not more than 5'-0" o.c. unless otherwise shown.

3. Provide wall return fittings of cast iron, flush type, with the same projection as that specified for wall brackets.

4. Longitudinal members shall be parallel with each other and with floor surface or shape of stair to a tolerance of 1/8" in 10'-0" linear feet. Center line of members within each run of railing shall be in the plane.

5. For steel pipe posts where indicated, anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized steel pipe, not less than six (6) inches long and having an inside diameter not less than 1/2" greater than outside diameter of the inserted pipe. Provide steel plate closure secure to bottom of sleeve and of width and length not less than one (1) inch greater than outside diameter of sleeve. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-shrink, non-ferrous grout. Cover anchorage joint with a round steel flange welded to post. Posts shall be set plumb within 1/8" vertical tolerance.

6. Steel pipe handrails shall be capable of resisting a two hundred (200) lb. force applied to rail from any direction and a uniformly distributed load of fifty (50) lbs. per linear foot applied downward or horizontally, loads not to act simultaneously.

D. Loose Steel Lintels: Provide loose structural steel lintels for openings and recesses in masonry walls and partitions as shown. Weld adjoining members together to form a single unit where indicated. Provide not less than eight (8) inches bearing at each side of openings, unless otherwise indicated.

1. Loose lintels shall conform to the following Schedule:

Opening Width (Maximum)	WALL THICKNESS		
	4 inches	6 inches	8 inches*
2'-0"	3-1/2" x 3-1/2" x 1/4"	6" x 4" x 5/16"	3-1/2" x 3-1/2" x 1/4"
3'-0"	3-1/2" x 3-1/2" x 5/16"	6" x 4" x 5/16"	3-1/2" x 3-1/2" x 5/16"

4'-0"	3-1/2" x 3-1/2" x 5/16"	6" x 4" x 5/16"	3-1/2" x 3-1/2" x 5/16"
5'-0"	4" x 3-1/2" x 3/8"	6" x 4" x 3/8"	4" x 3-1/2" x 5/16"
6'-0"	5" x 3-1/2" x 3/8"	6" x 4" x 3/8"	5" x 3-1/2" x 5/16"
7'-0"	5" x 3-1/2" x 3/8"	5" x 5" x 1/2"	5" x 3-1/2" x 3/8"
8'-0"	5" x 3-1/2" x 3/8"	5" x 5" x 5/8"	5" x 3-1/2" x 3/8"

* Two angles at all openings in eight (8) inch walls.

2. At columns or vertical surfaces where lintels cannot bear on masonry, provide clip angles sized for structural capacity of lintel.

E. Loose Bearing and Leveling Plates: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

F. Miscellaneous Light Steel Framing

1. Light steel framing, bracing, supports, framing, clip angles, shelf angles, plates, etc., shall be of such shapes and sizes as indicated on the drawings and details or as required to suit the condition and shall be provided with all necessary supports and reinforcing such as hangers, braces, struts, clip angles, anchors, bolts, nuts, welds, etc., as required to properly support and rigidly fasten and anchor same in place and to steel, concrete, masonry and all other connecting and adjoining work.

2. All light steel framing steel shall be furnished and erected in accordance with the applicable requirements of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" by the American Institute of Steel Construction and as specified herein.

G. Miscellaneous Steel Trim: Provide shapes and sizes for profiles shown. Except as otherwise indicated, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.

H. Shelf Angles

1. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4" bolts, spaced not more than 6" from ends and 24" o.c., unless otherwise indicated.

   a. Provide mitered and welded units at corners.
   b. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2" larger than expansion or control joint.

2. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

3. Galvanize and prime shelf angles located in exterior walls.

4. Prime shelf angles located in exterior walls with primer specified in Section 099000, "Painting and Finishing," for high-performance coatings.

5. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

I. Countertop Supports: Steel framing as indicated or required to support countertops. Conceal framing under countertops and within wall behind countertops. Provide supports to withstand a concentrated load of not less than three hundred (300) lbs. applied at any point with a deflection not to exceed L/240 for the length of the countertop.

J. Masonry Support Steel

1. Provide galvanized steel, relieving angles, plates, accessories and other steel shapes for masonry support steel; for lintels refer to Para. D. herein.

2. Fabricate masonry support steel to allow final adjustment with the closest tolerances possible. Relieving angles which require cutting to fit masonry flashing shall be straightened without deflections.

3. Coordinate masonry support system with concrete work for locations of wedge inserts.

4. Install to meet requirements of building masonry work, face brick coursing and stone placement. Coordinate final adjustments with masonry work as work progresses.

K. Sleeves in Concrete Walls and Slabs

1. Sleeves through concrete walls shall be of Schedule 40 steel pipe with i.d. two (2) inches larger than o.d. of pipe or conduit (including insulation, if any) to be accommodated. Sleeves shall project one-half (1/2) inch on each side of finished wall. Provide rectangular one-quarter (1/4) inch steel plate collar at center, continuously welded to the perimeter of the sleeve, and six (6) inches wider than the o.d.

2. Slots in slabs shall be 12 gauge steel sheet, galvanized, of dimensions indicated, with strap anchors welded in place not more than twelve (12) inches on centers.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where miscellaneous metal is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 ERECTION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

B. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry, or similar construction.

C. Fitting Connections: Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance, and quality of welds made, and methods used in correcting welding work.

E. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

F. Field Touch-Up of Galvanized Surfaces: Touch-up shop applied galvanized coatings damaged during handling and installation. Use galvanizing repair coating specified herein for galvanized surfaces.

END OF SECTION

SECTION 055113

STEEL PAN STAIRS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the steel pan stairs as indicated on the drawings and specified herein, including but not limited to, the following:

1. Steel pan stairs, including all clips, hangers, inserts, braces and other supports.

2. Steel pipe handrails, guardrails and intermediate rails for steel stairs, including supports, brackets, and anchors.

1.3 RELATED SECTIONS

A. Structural Steel - Section 051200.

B. Miscellaneous Metals - Section 055000.

C. Installation of inserts in drywall furnished by this Section - Section 092900.

D. Resilient Base and Accessories - Section 096513, for resilient stair treads.

E. Finish painting - Section 099000.

1.4 QUALITY ASSURANCE

A. Qualification of Welders: Use only certified welders and the shielded arc process for all welding performed in connection with the work of this Section. Protect adjacent surfaces when field welding to prevent damage or stain. Welders and welding operators must be qualified by tests as provided by AWS.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with:

1. "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.

2. "Code for Welding in Building Construction" of the American Welding Society.

3. "Metal Stairs Manual" of the National Association of Architectural Metal Manufacturers.

C. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards of these specifications, the provisions of the more stringent shall govern.

D. Field Measurements: If construction process permits, take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress. Allow for trimming and fitting wherever taking field measurements before fabrication might delay work.

E. Tolerances: Allow for construction tolerances as required.

F. Coordination: Coordinate this work with the work of all other trades interfacing with metal pan stairs, such as structural openings, sprinklers and standpipes, and other trades as required.

1.5 DRAWING SUBMISSION

A. General: It is the intent of the Working Drawings to display the layouts and general design parameters upon which the Shop Drawings shall be developed. Detail development and all connections shall be part of Shop Drawing Development.

B. Shop Drawings

1. Before any steel stairs are fabricated, submit shop drawings to the Architect for approval.

2. Show all locations, markings, quantities, materials, sizes and shapes, and indicate all methods of connecting, anchoring, fastening, bracing, for the stair construction, support and attachment to the work of other trades.

C. Engineering Data

1. Before any metal pan stairs are fabricated, submit engineering data drawings to the Architect for review. The Contractor is responsible for the structural design and supports for the stair system and must show his proposed system on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of stair members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

1.6 SAMPLES SUBMISSION

A. Submit the following listed samples and other samples as may be requested by the Architect, to show the quality standards:

1. Railing bracket.

2. Exposed weld.

3. Exposed bolted connection.

4. Bent pipe railing.

B. Samples shall be submitted cleaned and shop primed and shall represent standards to which all respective materials used in the Project shall meet.

1.7 PERFORMANCE STANDARDS

A. Stairs and railings shall be constructed to conform to the following performance standards, unless greater required by Code:

1. Stairs and platforms shall support a live load of one hundred (100) psf and a concentrated live load of three hundred (300) lbs. and shall have a live load deflection limited to 1/360 of the span. Loads shall not apply simultaneously.

2. Railings shall withstand a two hundred (200) lb. force applied to rail from any direction, and a uniformly distributed load of 50 lbs./lin. ft. applied downward or horizontally, loads not to act simultaneously.

1.8 PRODUCT HANDLING

A. Protection: Use all means necessary to protect steel pan stair before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. Structural Steel: ASTM A 36.

B. Steel Sheets: ASTM A 245, Grade C, minimum ten (10) gauge for platforms, twelve (12) gauge minimum for treads and risers.

C. Steel Pipe: ASTM A 53, Type E., Grade A, and ASTM A 501. Use standard malleable iron fittings for steel pipe.

D. Malleable Iron Castings: ASTM A 47, Grade 35018.

E. Bolts and Nuts: ASTM A 307, Grade A bolts.

F. Machine Screws: ASME B 18.6.3.

G. Expansion Bolts: "Cinch" type, galvanized, of approved manufacture.

H. Threaded End Hanger Rods: Minimum 3/4" diameter, ASTM A 36.

I. Shop Paint: Shop prime all stairs and railings using Series 88 Azeron Primer made by Tnemec, ICI Devoe "Rust Guard" quick dry alkyd shop coat No. 41403, or "Interlac 393" by International Protection Coatings.

J. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D1187.

K. Concrete Fill and Reinforcing Materials

1. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 3000 psi.

a. Where resilient stair treads and indicated, concrete shall have a trowel finish.

2. Welded Wire Fabric: ASTM A 185, 6 by 6 inches – W1.4 by W1.4, unless otherwise indicated.

2.2 FABRICATION

A. General

1. Steel pan stair work shall be fabricated by an experienced manufacturer in accordance with approved shop drawings and best practices of the industry, using new and clean materials as

specified, having structural properties sufficient to safely sustain or withstand strains and stresses to which material will be subjected.

2. Fabricate shop assemblies in largest practical sizes to minimize field work. All exposed surfaces shall be clean and free from all dirt, stains, grease marks, scratches, waves, dents, buckles, tool marks, rattles, and other objectionable defects which mar appearance or use of finished work.

3. Cutting: Cut materials by sawing, shearing, or blanking. Flame cutting will be permitted when ground back to clean edges. Cuts shall be made accurately, clean, sharp and free of burrs, without deforming adjacent metals.

4. Connections: Make connections with tight joints, capable of developing full strength of the members, flush. Locate joints where least conspicuous. Use concealed fasteners where possible. Weld or rivet shop connections; bolt, screw or weld field connections.

   a. Welding: Welds shall be continuous, except where spot welding is specifically permitted. Welding shall conform to the Standard Code of the American Welding Society. Exposed welds are required to be ground flush.
   b. Bolts and Screws: Make threaded connections tight with threads entirely concealed. Use lock nuts, or upset thread ends. Exposed bolts and screw head shall be flat and countersunk, unless otherwise indicated on drawings. Remove projecting ends of bolts and screws. Punch or drill holes; do not burn.

B. Stairs and Platforms

1. Provide stringers, risers, sub-treads and platforms matching profiles as shown. Form tread pan and riser in a continuous piece to receive the finished tread; tread shall be a minimum of twelve (12) gauge. Weld risers and treads to carrier angles which shall be welded to the structural steel stringers. Fasten countersunk bolts or stud welded clips through mesh for cement fill. Provide welded-on clips for the support of gypsum drywall soffits.

2. On intermediate platforms, provide metal bases formed of stringers. Miter and weld and grind smooth internal and external corners of metal bases. Form platform runs of minimum ten (10) gauge steel.

3. Countersink bolt heads and screws on finished surfaces or cut off flush with such surfaces.

4. Properly fit and securely fasten together all parts making exposed joints close fitting. Cut, drill, punch and tap as required for installation.

5. Make joints as strong and rigid as adjoining sections. Weld continuously along entire line of contact except where spot welding is indicated.

6. Separate dissimilar metals in or adjacent to work of this Section with a coat of bituminous paint on each surface prior to installation.

7. Closure and Filler Plates: Where indicated on drawings or as required, at least twelve (12) gauge sheet steel, securely fastened to top and bottom of stringer and adjacent wall, by welding or screws.

8. Struts, Hangers, Platform Headers and Subframing

   a. Provide supports as detailed and required, including all struts, clip angles, angles or hangers which are required and necessary for support of stair construction.
   b. Supports shall be of size suitable for the support load, as required. Struts, angles and hangers shall be supported by and directly connected to the structural framing. Struts and hangers, with their connections, shall be concealed.

c. Provide other inserts, anchors and/or other subframing as may be required to complete the stair construction and properly support it on the structural framing.

C. Handrails, Railings, Posts and Brackets

1. Provide steel pipe of size shown on drawings, Schedule 40. Use heavier weight pipes and/or reinforce pipes internally as required to meet performance standards given in paragraph 1.7 herein. Fittings shall be flush type, malleable or cast iron. Wall brackets shall be steel design as detailed.

2. Handrail, post and railing spacing shall meet Code requirements.

3. Construction: Form direction changes in rails using solid bar stock or elbows. Connections shall be shop welded, except where expansion joints are required. Field connections shall be welded for continuity. All exposed welds shall be ground smooth and flush.

a. If elbows are not available for angles shown, bends shall maintain full diameter of pipe, use mandrel, no kinks, ripples, flats are acceptable.

4. Fabricate newel or steel tubing with wall thickness of 0.120" and provide gray iron casting newel caps.

5. Anchor posts to steel with steel flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

6. Secure handrails to walls with wall brackets. Provide brackets as shown on drawings. For installation in drywall, furnish Drywall Section steel plate to receive wall plate portion of bracket and anchor or bolt wall plate through drywall to supporting steel plate. Locate brackets at not more than 5'-0" o.c. unless otherwise shown.

7. Anchor rail ends into adjacent walls with steel flanges welded to rail ends and anchored into the wall construction as described above.

2.3 SHOP PAINTING

A. Scope: All ferrous metal shall be cleaned and shop painted with one coat of specified ferrous metal primer.

B. Cleaning: Conform to Steel Structures Painting Council Surface Preparation Specification SP 3 (latest edition) "Power Tool Cleaning" for cleaning of ferrous metals which are to receive shop prime coat.

C. Application

1. Apply shop prime coat immediately after cleaning metal. Apply paint in dry weather or under cover. Metal surfaces shall be free from frost or moisture when painted. Paint all metal surfaces including edges, joints, holes, corners, etc.

2. Paint surfaces which will be concealed after shop assembly prior to such assembly. Apply paint in accordance with approved paint manufacturer's printed instructions, and the use of any thinners, adulterants or admixtures shall be only as stated in said instructions.

3. Paint shall uniformly and completely cover the metal surfaces, 2.0 mils minimum dry film thickness. No work shall be shipped until the shop prime coat thereon has dried.

D. Touch-Up: In the shop, after assembly and in the field, after installation of work of this Section, touch-up damaged or abraded portions of shop prime paint with specified ferrous metal primer.

E. Apply one shop coat to fabricated metal items, except apply two (2) coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where steel pan stairs are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Work in the field shall comply with the same requirements as specified for shop work above.

B. Except where otherwise shown or specified for a particular item of work or for built-in work, fasten metal work to solid masonry with expansion bolts. Fastenings to wood plugs in masonry will not be accepted. Drill holes to the exact diameter of the bolts using a rotary drill for concrete and a percussion drill for other masonry. Thread screws full length to the head of the screw.

C. Provide connecting members needed for properly securing the work to masonry, drywall and structural framing, including bolts, machine screws, rods, hangers, inserts, sleeves, plates, anchors, expansion bolts, washers and other items as required. Furnish built-in items to drywall trades as required for proper anchorage.

D. Leave work exposed to view, including stair soffits, clean, smooth and neatly finished. All exposed welds shall be dressed smooth.

E. Include supplementary parts necessary to complete each item even though such work is not definitively shown or specified.

F. Coordinate and schedule the work of this Section with the work of other trades. Furnish anchors, sockets, fastenings and other miscellaneous items to be embedded in concrete or masonry, or required for securing metal work to other construction so as not to delay job progress.

G. Attach wall railings to the wall construction, using appropriate bolts and anchors to meet performance standards.

H. Install work plumb and true to the exact lines and levels, in the correct location and in proper relation to adjoining work.

I. Touch up marred and abraded shop paint of exposed surfaces after erection in the field.

J. Posts shall be set plumb within 1/8" vertical tolerance. Longitudinal members shall be parallel with each other and with floor surface or slope of stair to a tolerance of 1/8" in ten (10) linear feet. Center lines of members within each run of railing shall lie in the same vertical plane. Field joints of connecting sections shall be hairline.

3.3 TOUCH-UP PAINTING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop coat, and paint exposed areas with same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION

SECTION 05 59 01

METAL EDGING

PART 1 — GENERAL

1.1 SUMMARY

A. Provide metal edging work required for paving and landscape edges as indicated on Drawings and as specified herein. Include, but do not limit to:

1. Flat vertical Steel Edging at transitions between different planting, pavements, and surface treatments.
2. “L” shaped Paver Edge Restraints

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 321216, BITUMINOUS CONCRETE PAVING.
2. Section 321313, LANDSCAPE CAST-IN-PLACE CONCRETE.
3. Section 321440, SAND SET UNIT PAVING.
4. Section 321448, CRUSHED STONE SURFACING.
5. Section 329100, PLANTING SOIL.
6. Section 329300, TREES, PLANTS AND GROUNDCOVERS.

1.3 REFERENCES

A. Comply with applicable requirements of following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Society for Testing and Materials (ASTM):

A 36	Structural Steel
A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 386	Zinc Coating (Hot-Dip) on Assembled Steel Products

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.

B. Shop Drawings:
1. Submit Shop Drawings of manufactured units and fabricated items for acceptance prior to fabrication.

2. Show shop and erection details including dimensions, sizes, thicknesses, gauges, finishes, joining, attachments, holes, welds, bolts, screws, elevations and relationship of work to adjoining construction, including finished soil grades and finished paving surfaces.
3. Where welded connectors, concrete, or masonry inserts are required to receive Work, show exact locations required.
4. Where items must fit and coordinate with finished surfaces and/or constructed spaces, take measurements at site and not from Drawings.
5. Indicate welded connections using standard AWS A2.4 welding symbols.
6. Furnish accepted Shop Drawings to the trades responsible for installing the connectors or inserts.

C. Samples:
1. Steel Edging: One 12-inch long piece
2. Paver Edge Restraint: Three 6-inch long pieces

1.5 QUALITY ASSURANCE

A. Source: Obtain each type of material or product that will be visible from a single source that has resources required to provide material of consistent quality, physical properties, and appearance.

B. Regulatory Requirements: Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.

C. General Requirements for Mock-ups:
1. Construct as many mock-ups as necessary to achieve an accepted mock-up.
2. Mock-up which is completely or partially finished incorrectly will be rejected.
3. Remove rejected mock-ups immediately from the site.
4. Mock-ups may be installed and remain as part of the permanent installation if acceptable by the Landscape Architect.
5. The mock-ups, when accepted, shall become the project standard for tolerances and appearance.

D. Paver Retention Angle Mock-up:
1. Install retention angle on at least two edges of the concrete unit paving mock-ups.
2. Include angle corner on sand-set concrete unit paving mock-up to demonstrate how 2 angle pieces meet.
3. Include at least one gap between angle piece ends on side edge of sand-set concrete unit paving mock-up.
4. Coordinate with and meet mock-up requirements of Section 32 14 40.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protective Pads: Use suitable protective pads and covers to prevent damage and staining of finishes of metal pieces and fabrications when lifting, handling and shipping.

B. Bracing: Brace and support metal pieces and fabrications adequately during handling to prevent structural damage.

1.7 WARRANTY

A. General Description: Warrant Work for a period of one year from the Date of Final Completion against defects in materials and workmanship.

B. Additional Items Covered: Warranty shall also cover repair of damage to other materials and workmanship resulting from defects in materials and workmanship.

C. Exceptions: Contractor shall not be held responsible for failures due to normal wear, neglect by Owner, vandalism, and other causes outside Contractor's control.

PART 2 — PRODUCTS

2.1 METAL

A. General: Provide products and materials of new stock, free from defects, and of best commercial quality for each intended purpose.

B. Steel Plates, Shapes, and Bars: ASTM A 36.

2.2 STEEL EDGING

A. Steel edging shall be 'BORDER KING', manufactured by Border Concepts, Charlotte, NC, Tel.: (800) 845-3343; **info@borderconcepts.com**, or approved equal. Steel edging shall be shop fabricated, ¼ in. thick x 5 in. deep, in galvanized finish. Edging shall be furnished in minimum 10 ft. lengths.

1. Steel edging shall comply with ASTM A 569, hot-rolled, standard flexible carbon steel landscape edging
2. Steel edging shall have slotted holes for staking steel edging, 7 per 16 ft. long section.
3. Provide manufacturer's standard touch-up paint for in field touch-up of scratched or marred areas

2.3 STEEL LANDSCAPE EDGING STAKES

A. Steel, tapered, 15" minimum length, and finished to match specified steel landscape edging. Stakes designed specifically to anchor steel landscape edging in place, and shall be made by the manufacturer of the steel landscape edging for which they will be used.

2.4 PAVER EDGE RESTRAINTS

A. Paver edge restraints shall be 'A.P.E EDGE', manufactured by Border Concepts, Charlotte, NC, Tel.: (800) 845-3343; **info@borderconcepts.com**, or approved equal.

1. Edge restraint at concrete pavers shall be shop fabricated steel, ¼ in. thick x 4 in. deep with 4 in. shelf, in galvanized finish. Edge restraint shall be furnished in minimum 10 ft lengths with preformed holes for fastening.

2. Edge restraint at bituminous concrete pavement shall be shop fabricated steel, 3/16 in. thick x 3 in. deep with 3 in. shelf, in galvanized finish. Edge restraint shall be furnished in minimum 10 ft lengths with preformed holes for fastening.

2.5 EDGE RESTRAINT FASTENING

A. Anchors: 3/8 inch x 10 inches (9.5 mm x 254 mm) bright spiral steel spike, 3/16 inch x 1-1/2 inches (4.8 mm x 38 mm) or longer Ardox concrete nail, or drive pin fastener equal to Hilti DX 40 powder actuated pin or Ramset Trakfast Automatic Fastening System pin.

B. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 — EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of metal edging.

1. Notify the construction manager of unsuitable conditions.
2. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Coordinate site metal fabrications with adjoining work for details of attachment, fittings, etc.

B. Provide anchorage devices and fasteners where needed to secure metal edging to in-place construction.

C. Perform cutting, drilling, and fitting required to install metal edging. Set edging accurately to correct locations and positions with edges and surfaces level, plumb and true, except where indicated otherwise.

D. Field Welding:
1. Meet requirements of AWS D1.6 and AWS D1.1 for respective steel types.
2. Welding will be permitted only where indicated or accepted on the Shop Drawings.
3. Grind visible welds smooth and finish so that joints are not visually detectable, unless accepted otherwise.

E. Corners: Miter corners of paving retention angles, frames and other fabrication corners, unless indicated otherwise.

F. Backfill material on each side of edge shall be as specified for adjacent surface and shall be thoroughly compacted by means of power tampers. Extreme care shall be taken not to destroy alignment. Curb sections disturbed during backfilling or otherwise shall be reset to line and grade, and properly backfilled.

3.3 STEEL EDGING

A. Steel edging shall be installed at locations indicated on the Drawings. Where required, edging shall be cut square and accurately to required length.

1. Steel edging shall be securely staked in required position, even with adjacent finished paving surface.
2. Stakes shall be driven in all factory stake slots along length of edging.
3. Adjacent lengths of edging shall overlap 8 in.
4. Edging shall be set plumb and vertical at required line and grade. Straight sections shall not be wavy; curved sections shall be smooth and shall have no kinks or sharp bends.
5. Install extra stakes between factory stake locations where needed to straighten edging, as directed by Architect in the field.
6. Install shop-bent edging at corners in lieu of corner stakes to eliminate joints at corners.

3.4 PAVER EDGE RESTRAINTS

A. Anchorage: Install as indicated on the Drawings and in accordance with manufacturer's instructions.
1. Anchorage over aggregate shall use spiral steel spikes.

2. Anchorage over concrete shall use concrete nail or Ramset/Hilti fastner in accordance with Part 2 of this specification.

B. Leveling Angles: Level angles using leveling nuts and shims before installing grout.

C. Straightening Paver Retention Angles: Straighten plates and angles as required to meet the erection tolerances indicated.

D. Gaps at Paver Retention Angle Piece Ends: To allow for thermal movement of paving, install angles with 1/16-inch gap between piece ends along concrete unit paving.

E. Gaps at Bituminous Concrete Pavement installation: Install with manufacturer's recommended gap between sections to allow for themal expansion when heated by hot-mix asphalt.

3.5 ERECTION TOLERANCES

A. Paver Retention Edge Vertical Leg: 1/16-inch maximum from plumb.

B. Paver Retention Edge Out-Of-Position: 1/16-inch maximum.

C. Paver Retention Edge Pieces Out-Of-Alignment: 1/32-inch maximum.

3.6 CLEANING

A. Remove soil and foreign matter from finished surfaces and keep clean until the Owner accepts maintenance.

3.7 TOUCH-UP REPAIR

A. After erection abraded areas of edging surfaces shall be touched-up and repaired with manufacturer's standard materials.

END OF SECTION

SECTION 057000

ORNAMENTAL METALS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the ornamental metals, including heavy gauge stainless steel and non-ferrous metal products which are used in building construction for functional, architectural, and decorative effects, and which are not a part of other metal systems specified in other Sections. The extent of these items is indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Decorative steel railings and handrails.
2. Custom painted steel picket guardrail with posts.
3. Interior stainless steel railings.
4. Bent aluminum.
5. Brass panels.
6. Aluminum panels.
7. Metal mesh drapery panels.
8. Metal fascias.
9. Formed metal panels at side of Stair 2 and lobby fascia.
10. Additional decorative metal items as scheduled on the drawings.

1.3 RELATED SECTIONS

A. Miscellaneous Metals - Section 055000.

1.4 QUALITY ASSURANCE

A. General: Work of this section shall be fabricated and installed by an experienced fabricator or manufacturer who has been engaged in work of equivalent scope and fabrication standards for at least five (5) years. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and erection shall be in accordance with drawings, specifications, and approved shop drawings, and be of highest quality practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. All work shall be accurately and neatly fabricated, assembled, and erected.

B. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job progress; allow for adjustments and fitting where taking of field measurements before fabrication might delay the work.

C. Shop Assembly: Insofar as practicable, fitting and assembly of work shall be done in shop. Work that cannot be permanently shop assembled, shall be completely assembled, marked and disassembled in shop before shipment to insure proper assembly in field. Shop assemble work in largest practical sizes to minimize field work. It is the responsibility of the Contractor for this work to assure himself that the shop fabricated items will properly fit the field condition. In the event that shop fabricated items do not fit the field condition, the item shall be returned to the shop for correction.

1.5 SUBMITTALS

A. Shop Drawings: Submit for all items of work of this Section, as enumerated under paragraph 1.2, showing locations, layouts, materials, thicknesses, finishes, dimensions, construction, relation to adjoining construction, erection details, profiles, jointing and all other details to fully illustrate the work of this Section.

B. Samples: Submit fabricated samples (of sufficient size to fully show construction, materials and finishes) of all items of work as enumerated under paragraph 1.2 herein.

C. Product Data: Submit manufacturer's, fabricator's and finisher's specifications and installation instructions for products used in ornamental metal work, including finishing materials and methods.

D. Samples for Verification: For each type of exposed finish required, prepared on 12" x 12" samples of metal of same thickness and material indicated for the Work.

E. Contractor Licensed Engineer Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments and necessary clearances.

1.6 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors, that are to be embedded in concrete to masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim and joint sealants, are protected against damage from the effects of weather, age, corrosion and other causes.

1.7 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

1.8 PERFORMANCE STANDARDS FOR RAILINGS (UNLESS GREATER REQUIRED BY CODE)

A. Railing assemblies shall be designed and installed to resist the simultaneous application of a lateral force of 50 PLF and a vertical load of 100 PLF, both applied to the top of the railing. Railings shall resist a total lateral force and total vertical load of at least 200 lbs. each.

B. Submit calculations and drawings signed and sealed by a Professional Engineer licensed in the State of New York indicating that railing system can meet these performance criteria.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide materials which have been selected for their surface flatness, smoothness and freedom from surface blemishes where exposed to view in the finished unit. Surfaces exposed to view that exhibit pitting, seam marks, roller marks, oil-canning, stains, discolorations, or other imperfections on the finished units will not be acceptable.

B. Steel and Iron

1. Comply with the following standards for the forms and types of steel and iron for the required items of work.

a. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
b. Bars: Hot-rolled, carbon steel complying with ASTM A 29, Grade 1010.
c. Plates, Shapes, and Bars: ASTM A 36.
d. Cast Iron: Either gray iron, ASTM A 48, or malleable iron, ASTM A 47 unless otherwise indicated.
e. Steel Sheet, Cold Rolled: ASTM A 1008, either commercial steel or structural steel, exposed.

2. Steel (Carbon) for Concealed Supports Only

a. Structural Shapes: ASTM A 36.
b. Plates (for forming or bending cold): ASTM A 283, Grade C.
c. Steel Sheets: ASTM A 366, Grade 1.
d. Shop prime with rust inhibitive primer equal to Series 88 Azeron made by Tnemec or approved equal made by Benjamin Moore or Sherwin Williams.

3. Malleable Iron Castings: ASTM A 48, Class 30, and shall be uniform in quality, free from blow holes, porosity, hard spots, shrinkage defects, swells, cracks or other defects. Surfaces shall be smooth and true to pattern.

4. For steel to receive blackened finish, use uncoated, hot-rolled steel sheet, ASTM A 1011, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

C. Aluminum: Comply with the following standards for the forms and types of aluminum for the required items of work.

1. Alloy and Temper: Provide alloy and temper as indicated or as otherwise recommended by the aluminum producer or finisher.

a. Aluminum Extrusions, Bars and Shapes: Alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 221 for 6063-T6.

b. Extruded Pipe and Tube: ASTM B 429, alloy 6063-T6.
c. Aluminum Plate and Sheet: Alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 209, alloy 6061-T6.
d. Bars, Rods and Wire: ASTM B 211.
e. Drawn Seamless Tube: ASTM B 483, alloy 6063-T832.
f. Castings: ASTM B 26; alloy A356-T6.
g. Forgings: ASTM B 247, alloy 6061-T6.

D. Stainless Steel: Comply with the following standards for the forms and types of stainless steel for the required items of work.

1. Tubing: ASTM A 554, Grade MT 304.

2. Pipe: ASTM A 312, Grade TP 304.

3. Castings: ASTM A 743, Grade CF 8 or CF 20.

4. Sheet, Strip, Flat Bar and Plate: ASTM A 666, Type 304.

5. Bars and Shapes: ASTM A 276, Type 304.

E. Bronze: Comply with the following standards for the forms and types of bronze for the required items of work.

1. Temper: Provide bronze materials in standard commercial tempers and hardness, as required for fabrication, strength and durability.

a. Extruded Shapes: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
b. Plates and Bars: ASTM B 36, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
c. Seamless Tube: ASTM B 135, Alloy UNS No. C23000 (red brass, 85 percent copper).
d. Seamless Pipe: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
e. Composition Bronze Castings: ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or composition bronze).

F. Brass: Comply with the following standards for the forms and types of brass for the required items of work.

1. Temper: Provide brass materials in standard commercial tempers and hardness, as required for fabrication, strength and durability.

a. Plate, Sheet, Strip and Bars: ASTM B 36, Alloy UNS No. C26000 (cartridge brass, 70 percent bronze).
b. Seamless Tubes: ASTM B 135; Alloy UNS No. C26000 (cartridge brass, 70 percent bronze).
c. Extruded Shapes: ASTM B 249, Alloy UNS C36000 (free cutting brass).
d. Sand Castings: ASTM B 584, Alloy UNS No. C85200 (high copper yellow brass).

G. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of the metal to be welded, and as required for color match, strength and compatibility in the fabricated items.

H. Fasteners: Furnish basic metal and alloy, matching finished color and texture as the metal being fastened, unless otherwise indicated. Provide Phillips flat-head screws for exposed fasteners, unless otherwise indicated.

I. Anchors and Inserts: Either furnish inserts to be set in concrete or masonry work, or provide other anchoring devices as required for the installation of ornamental metal items. Provide toothed steel or lead

shield expansion bolt devices for drilled-in-place anchors. Provide galvanized or cadmium-coated anchors and inserts for exterior installations.

1. Provide units with exposed surfaces matching the texture and finish of the metal item anchored.

J. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

K. Cast-in-Place and Preinstalled Anchors: Anchors fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete.

L. Sealants, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834; of type and grade required to seal joints in decorative formed metal; and as recommended in writing by decorative formed metal manufacturer.

1. Sealants shall have a VOC content of not more than 250 g/l when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by produced of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

2.2 FABRICATION

A. Cutting: Cut metal by sawing, shearing or blanking. Flame cutting will be permitted only if cut edges are ground back to clean, smooth edges. Make cuts accurate, clean, sharp, square and free of burrs, without deforming adjacent surfaces or metals.

B. Holes: Drill or cleanly punch holes (do not burn), so that holes will be accurate, clean, neat and sharp without deforming adjacent surfaces or metals.

C. Connections

1. Make connections with tight joints, capable of developing full strength of member, flush unless indicated otherwise, formed to exclude water where exposed to water. Locate joints where indicated on drawings. Provide connections to allow for thermal movement of metal at locations and by methods approved by Architect. For work exposed to view, use concealed fasteners (unless welded or other connections indicated) with joints accurately fitted, flush and rigidly secured with hairline contacts. All edges within public reach shall be eased.

2. Welding: Welding shall be in accordance with recommendations of the American Welding Society and shall be done with electrodes and/or methods recommended by the manufacturers of the metals being welded. Welds shall be continuous, except where spot welding is specifically permitted. Welds exposed to view shall be ground flush and dressed smooth with and to match finish of adjoining surfaces so that joint will not be visible; undercut metal edges where welds are required to be ground flush and dressed smooth. All welds on or behind surfaces which will be exposed to view shall be done so that finished surface will be free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Remove weld splatter and welding oxides from all welded surfaces.

3. Brazing (for Brass and Bronze): Brazing shall be in accordance with recommendations of the producer of the metal, using type and alloy of filler metal and electrodes as required for color match, strength and compatibility in the fabricated items. Brazing shall be continuous. Brazed surfaces exposed to view shall be ground flush and dressed smooth with and to match finish of adjoining

surfaces so that joint will not be visible; undercut metal edges where brazed surfaces are required to be ground flush and dressed smooth. All brazed surfaces on or behind surfaces which will be exposed to view shall be done so that finished surface will be free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Remove splatter and oxides from all brazed surfaces.

4. Bolts and Screws: Make threaded connections tight with threads entirely concealed. Use lock nuts. Bolts and screw heads, where shown to be exposed to view, shall be flat and countersunk. Cut off projecting ends of exposed bolts and screws flush with nuts of adjacent metal.

D. Operating Mechanism: Operating devices, mechanism and hardware used in connection with this work shall be fabricated, assembled, installed and adjusted after installation so that they will operate smoothly, freely, noiselessly and without excessive friction.

E. Built-In Work: Furnish anchor bolts, inserts, plates and any other anchorage devices, and all other items for architectural metal work to be built into concrete, masonry, or work of other trades, with necessary templates and instructions, and in ample time to facilitate proper placing and installation.

F. Supplementary Parts: Provide as necessary to complete each item of work, even though such supplementary parts are not shown or specified.

G. Coordination: Accurately cut, fit, drill and tap work of this Section to accommodate and fit work of other trades. Furnish or obtain, as applicable, templates and drawings to or from applicable trades for proper coordination of this work.

H. Exposed Work: In addition to requirements specified herein or shown on drawings, all surfaces exposed to view shall be clean, and free from dirt, stains, grease, scratches, distortions, waves, dents, buckles, tool marks, burrs and other defects which mar appearance of finished work. Ornamental metal work exposed to view shall be straight and true to line or curve, smooth arrises and angles as sharp as practicable, miters formed in true alignment, profiles accurately intersecting, and with joints carefully matched to produce continuity of line and design. Exposed fastenings, where permitted, shall be of the same material, color and finish as the metal to which applied, unless otherwise indicated, and shall be of the smallest practicable size.

I. Materials used shall be of such strength, thickness and alloy that they are capable of meeting all standards and descriptions specified herein and as detailed on drawings.

J. Bending: Bend sheet metal to the required shape. Bent items shall be free of grain separation, oil canning or other distortion.

1. Square Bends: Back-cut sheets to attach maximum square bend possible, with maximum radius of 1/16 in.

2. Knife Edge Bends: Back-cut and back bevel sheets to attain sharpest bend possible, with maximum radius of 1/32 in.

2.3 SHOP FINISHING

A. General

1. Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated.

2. Provide colors or color matches as indicated on selected samples.

3. Protect mechanical finishes on exposed surfaces from damage by application of strippable temporary protective covering prior to shipment.

4. Corrosion Protection: Coat concealed surfaces which will be in contact with concrete, masonry, wood or dissimilar metals, in exterior work and work to be built into exterior and below grade walls and decks, with a heavy coat of bituminous paint. Do not extend coating onto exposed surfaces.

B. Steel and Iron Finishes

1. Galvanized Railings: Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.

   a. Comply with ASTM A 123 for hot-dip galvanized railings.
   b. Comply with ASTM A 153 for hot-dip galvanized hardware.
   c. Where galvanized railings are to be painted, do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   d. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

4. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

5. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

6. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

7. Shop-Painted Finish: Comply with Section 099000 "Painting and Finishing."

   a. Color: Match Architect's sample.

8. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

   a. Color: Match Architect's sample.

C. Blackened Steel Finish: Comply with AMS 2485K finish. Manufacturer: Cleveland Black Oxide or approved equal.

1. Items indicated to be fabricated of blackened steel shall be shop finished after fabrication and welding is complete. Shop finish shall consist of EZ Black 55 and Aquares 1200F by SurFin Chemical Corp (or approved equal); apply per manufacturer's recommendations. Finish should be consistently black and maintain zero rust coloring. Provide matte lacquered finish.

2. Prior to application of finish, clean steel per SSPC SP-3. Ensure that base material is scratch and defect free prior to patination. Work piece should conform to category AESS 1.

3. Protect surface of blackened steel from abrasion by coating with wax or oil.

D. Aluminum

1. High Performance Coating: AA-C12C42R1x, cleaned with inhibited chemicals, conversion coated with an acid-chromate-fluoride-phosphate treatment, and painted with organic coating specified below. Apply finish in strict compliance with paint manufacturer's instructions using a licensed applicator.

a. Fluorocarbon Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
b. Custom color and gloss as selected by the Architect.

E. Stainless Steel

1. Remove or blend tool and die marks and stretch lines into finish.

2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

a. Bright, Directional Polish: No. 4 finish.
b. Satin, Directional Polish: No. 6 finish.
c. Satin Reflective, Directional Polish: No. 7 finish.
d. Mirror-Like Reflective, Non-Directional Polish: No. 8 finish.

3. When polishing is complete, passivate and rinse surfaces. Remove foreign matter and leave surface chemically dry.

F. Bronze and Brass

1. Hand Rubbed Natural Satin Finish, Unlacquered: CDA-M31-M34-06x, fine satin directional textured mechanical finish followed by hand-rubbed directional textured mechanical finish, with clear organic coating specified below.

a. Clear Organic Coating: Air-dried acrylic coating; Incralac as developed by International Copper Research Corp., 1.0 mil minimum dry thickness.

2. Statuary Conversion Coating, Bright Relieved and Lacquered: CDA-M12-C55-06x. Mechanical Finish: matte finish as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed as specified, with clear organic coating specified above.

3. Color: Uniform, matching color of accepted sample.

2.4 PROTECTION

A. Provide necessary protection to all exposed surfaces of architectural metal work, so as to prevent damage, staining, discoloration, abrasion, etc., to these surfaces from time of shipment from factory to acceptance of work of this project. Protection shall be provided by wrappings, strippable coatings, or other means. After installation, remove protective paper or strippable coating and clean exposed surfaces, and then provide additional temporary protection to protect architectural metal work from damage during subsequent construction activities. Surfaces which are damaged, stained, discolored, abraded etc., shall be rejected and replaced with new materials, at no cost to the Owner.

2.5 STEEL FRAMING, BRACING, SUPPORTS AND REINFORCEMENTS

A. Steel framing, plate reinforcing, supplementary steel framing or reinforcing, bracket assemblies, and the like required for the support, framing, reinforcing, bracing, etc., of work of this Section shall be of such sizes and shapes as indicated on the drawings, or as required to suit the conditions, and shall be provided with all necessary supports and accessory items such as inserts, hangers, braces, struts, clip angles, anchors, bolts, nuts, welds, etc., as required to properly and rigidly fasten, anchor or attach work of this Section in place and to the concrete, masonry and other connecting and adjoining work.

2.6 ORNAMENTAL HANDRAILS AND RAILINGS

A. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

5. Form changes in direction of railing members by radius bends.

6. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces of handrail and railing components.

7. Provide wall returns at ends of wall-mounted handrails, close ends of returns.

8. Close exposed ends of handrail and railing members with prefabricated end fittings.

9. Brackets, Flanges, Fittings, and Anchors: Provide brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

    a. Furnish inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
    b. For railing posts set in concrete, provide preset sleeves of steel, not less than 6 inches long and inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.

2.7 ORNAMENTAL PERFORATED METAL

A. Fabricate from perforated sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.

2.8 METAL MESH DRAPERY PANELS

A. Metal Mesh Drapery: Whiting and Davis, "Large Ring Mesh."

1. Curtain Fabric: Copper mesh, 240" wide x 180" high maximum panel size.

2. Hanging Method: Rings.

3. Track: Steel with custom finish. Provide trolleys 6" o.c. or as required for drapery size.

4. See Section 055000 Miscellaneous Metals for blocking and support requirements for track.

5. Coordinate with window treatment installer for location of installation and as required to assure proper and adequate provision in the work of other trades for interface with the work of this Section. Final size to be determined by field measurements after finishes are in place.

2.9 METAL PANELS

A. Fabricate of aluminum as shown on drawings, minimum thickness of 3/16".

B. Metal panels, fascias, and other sheet or plate items must read as flat and free of bow, oil-canning, or read-through of stiffeners. To this end, exposed metal faces when supported in the building shall be of such flatness that the maximum uniform bow in 2 ft. shall not exceed 1/32", and the maximum overall variation in plane between high and low point within a panel shall not exceed 1/16".

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where ornamental metal work is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. General: Install work of this Section square, plumb, straight, true to line or radius, accurately fitted and located, with flush, tight hairline joints (except as otherwise indicated or to allow for thermal movement), with provisions for other trades, with provisions to allow for thermal movement, with provisions to exclude water where exposed to weather, and with attachment devices as required for secure and rigid installation. It is the responsibility of the Contractor to assure himself that shop fabricated architectural metal items will properly fit the field condition. In cases where the shop fabricated architectural metal items do not fit the field condition, the item shall be returned to the shop for correction.

B. Attachments

1. Unless otherwise indicated, work to be built into concrete or masonry shall be anchored with shop welded on galvanized steel strap anchors; work to be attached to concrete or masonry shall be anchored by bolts into embedded inserts or expansion shields; work attached to structural steel shall be anchored by welds or bolts; work attached to metals other than structural steel shall be anchored by bolts or screws. Power actuated fasteners not permitted unless approved by Architect. Provide all supplementary parts necessary to complete each item of work of this Section.

2. All attachment devices shall be of type, size and spacing to suit condition and as approved by Architect. Provide shims, slotted holes, or other means necessary for leveling, plumbing and other required adjustments. Attachment devices for work exposed to view shall be concealed, unless indicated otherwise. Where bolts or screws are permitted in work exposed to view, they shall be oval head and counter sunk, unless otherwise noted, with projecting end cut off flush with nuts or adjacent material, and shall match adjacent surfaces.

3. Do all necessary drilling, tapping, cutting or other preparations of surrounding construction in the field accurately, neatly and as necessary for the attachment and support of work of this Section, but obtain Architect's approval prior to such preparation to work of others.

C. Tolerances: All work of this Section shall be plumb, square, level, true to radius and correctly aligned within the following limitations:

1. Offset from true horizontal, vertical and design location shall not exceed 1/16" per ten (10) feet of length for any component, not cumulative.

2. Maximum offset from true alignment between abutting components shall not exceed 1/32".

D. All railings shall be installed to withstand loads as required by prevailing Building Code.

E. Do not cut or abrade finishes which cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units at Contractor's option.

F. Install concealed gaskets and joint fillers as the work progresses, so as to make the work soundproof or lightproof as required.

G. Restore protective coverings which have been damaged during shipment or installation of the work. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.

H. Retain protective coverings intact and remove simultaneously from similarly finished items to preclude non-uniform oxidation and discoloration.

I. Field Welding: Comply with AWS Code for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work.

3.3 CLEANING

A. Clean aluminum, steel and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Clean copper alloys (bronze and brass) according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

3.4 PROTECTION

A. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at the time of Substantial Completion.

B. Restore finishes damaged during construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 057100

DECORATIVE STAIRS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the decorative stairs as indicated on the drawings and specified herein, including, but not limited to, the following:

1. Wood-clad steel stair with wood treads and metal-and-glass handrails for interior stairs.

2. Formed metals – See 057000.

3. All clips, hangers, inserts, braces, and other supports for architectural stairs.

1.3 RELATED SECTIONS

A. Engineered Wood Plank Flooring - Section 096429.

1.4 QUALITY ASSURANCE

A. General: Work of this section shall be fabricated and installed by an experienced fabricator or manufacturer who has been engaged in work of equivalent scope and fabrication standards for at least five (5) years. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and erection shall be in accordance with drawings, specifications, and approved shop drawings, and be of highest quality practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. All work shall be accurately and neatly fabricated, assembled, and erected.

B. Qualification of Welders: Use only certified welders and the shielded arc process for all welding performed in connection with the work of this Section. Protect adjacent surfaces when field welding to prevent damage or stain. Welders and welding operators must be qualified by tests as provided by AWS.

C. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with:

1. "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.

2. "Code for Welding in Building Construction" of the American Welding Society.

3. "Metal Stairs Manual" of the National Association of Architectural Metal Manufacturers, for Architectural class stairs.

D. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards of these specifications, the provisions of the more stringent shall govern.

E. Field Measurements: If construction process permits, take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress. Allow for trimming and fitting wherever taking field measurements before fabrication might delay work.

F. Tolerances: Allow for construction tolerances as required.

G. Coordination: Coordinate this work with the work of all other trades interfacing with architectural stairs, such as structural and other trades as required.

1.5 DRAWING SUBMISSION

A. General: It is the intent of the Working Drawings to display the layouts and general design parameters upon which the Shop Drawings shall be developed. Detail development and all connections shall be part of Shop Drawing Development. Show metal thicknesses, arrangement and joining of components, and details indicating provisions for thermal movement and fastening.

B. Shop Drawings

1. Before any architectural stairs are fabricated, submit shop drawings to the Architect for approval.

2. Show all locations, markings, quantities, materials, sizes and shapes, and indicate all methods of connecting, anchoring, fastening, bracing, for the stair construction, support and attachment to the work of other trades.

C. Engineering Data

1. Before any architectural stairs are fabricated, submit engineering data drawings to the Architect for review. The Contractor is responsible for the structural design and supports for the stair system and must show his proposed system on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of stair members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

1.6 SAMPLES SUBMISSION

A. Submit the following listed samples and other samples as may be requested by the Architect, to show the quality standards:

1. Wood and Metal Finishes

a. Submit finish samples, 6" x 6", for finish system specified.
b. The samples submitted shall be representative of the workmanship and finishes of all work of this Section to be incorporated in the completed project.
c. Submit 12" long sample of railings for each type and thickness indicated.
d. Submit 12" x 12" sample of wood cladding for each type, thickness and profile indicated.

B. Samples shall be submitted cleaned and finished and shall represent standards to which all respective materials used in the Project shall meet.

1.7 PERFORMANCE STANDARDS

A. Stairs and railings shall be constructed to conform to the following performance standards, unless greater required by Code:

1. Stairs and platforms shall support a live load of one hundred (100) psf and a concentrated live load of three hundred (300) lbs. and shall have a live load deflection limited to 1/360 of the span. Loads shall not apply simultaneously.

2. Railings shall withstand a two hundred (200) lb. force applied to rail from any direction, and a uniformly distributed load of 50 lbs./lin. ft. applied downward or horizontally, loads not to act simultaneously.

1.8 PRODUCT HANDLING

A. Protection: Use all means necessary to protect architectural stair before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.

B. Steel and Iron

1. Steel Plates, Shapes and Bars: ASTM A 36.

2. Steel Bar Grating: ASTM A1011/A or ASTM A 36.

3. Steel Tubing: Cold formed, ASTM A 500; or hot rolled, ASTM A 501.

4. Structural Steel Sheet: Hot rolled, ASTM A 570; or cold rolled, ASTM A 611, Class 1; of grade required for design loading.

5. Galvanized Structural Steel Sheet: ASTM A 924, of grade required for design loading. Coating designation G90.

6. Steel Pipe: ASTM A 53, type and grade as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (Schedule 40), unless otherwise indicated.

7. Gray Iron Castings: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.

8. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.

9. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

10. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

C. Handrails: Metal railing; refer to Section 057100.

D. Wood Cladding: As selected by the Architect.

E. Aluminum Cladding: For under the stair.

F. Wood Treads and Risers: To match wood flooring specified in Section 096429.

G. Bituminous Paint: Cold-applied asphalt mastic, ASTM D 1187.

2.2 FABRICATION

A. General

1. Architectural stair work shall be fabricated by an experienced manufacturer in accordance with approved shop drawings and best practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand strains and stresses to which material will be subjected.

2. Fabricate shop assemblies in largest practical sizes to minimize field work. All exposed surfaces shall be clean and free from all dirt, stains, grease marks, scratches, waves, dents, buckles, tool marks, rattles, and other objectionable defects which mar appearance or use of finished work.

3. Cutting: Cut materials by sawing, shearing, or blanking. Flame cutting will be permitted when ground back to clean edges. Cuts shall be made accurately, clean, sharp and free of burrs, without deforming adjacent metals.

4. Connections: Make connections with tight joints, capable of developing full strength of the members, flush. Locate joints where least conspicuous. Use concealed fasteners where possible. Weld or rivet shop connections; bolt, screw or weld field connections.

   a. Welding: Welds shall be continuous, except where spot welding is specifically permitted. Welding shall conform to the Standard Code of the American Welding Society. Exposed welds are required to be ground flush and smooth.
   b. Bolts and Screws: Make threaded connections tight with threads entirely concealed. Use lock nuts, or upset thread ends. Exposed bolts and screw head shall be flat and countersunk, unless otherwise indicated on drawings. Remove projecting ends of bolts and screws. Punch or drill holes; do not burn.

B. Stairs and Platforms

1. Provide stringers, risers, sub-treads and platforms matching profiles as shown. Form tread pan and riser in a continuous piece to receive the finished tread. Weld risers and treads to carrier angles which shall be welded to the structural steel stringers. Fasten countersunk bolts or stud welded clips through mesh for cement fill.

2. On intermediate platforms, provide metal bases formed of stringers. Miter and weld and grind smooth internal and external corners of metal bases. Form platform runs of minimum ten (10) gauge steel.

3. Countersink bolt heads and screws on finished surfaces or cut off flush with such surfaces.

4. Properly fit and securely fasten together all parts making exposed joints close fitting. Cut, drill, punch and tap as required for installation.

5. Make joints as strong and rigid as adjoining sections. Weld continuously along entire line of contact except where spot welding is indicated.

6. Give ferrous metal surfaces a shop coat of primer where paint application is indicated. Before painting, thoroughly clean surfaces with wire brushes or other proper and effective means of removing loose scale, filings or other objectionable materials.

7. Remove grease prior to painting. Separate dissimilar metals in or adjacent to work of this Section with a coat of bituminous paint on each surface prior to installation.

8. Closure and Filler Plates: Where indicated on drawings or as required, at least twelve (12) gauge sheet steel, securely fastened to top and bottom of stringer and adjacent wall, by welding or screws.

9. Struts, Hangers, Platform Headers and Subframing

   a. Provide supports as detailed and required, including all struts, clip angles, angles or hangers which are required and necessary for support of stair construction.
   b. Supports shall be of size suitable for the support load, as required. Struts, angles and hangers shall be supported by and directly connected to the structural framing. Struts and hangers, with their connections, shall be concealed.
   c. Provide other inserts, anchors and/or other subframing as may be required to complete the stair construction and properly support it on the structural framing.

2.3 SHOP FINISHING

A. General

1. Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated.

2. Protect mechanical finishes on exposed surfaces from damage by application of strippable temporary protective covering prior to shipment.

3. Corrosion Protection: Coat concealed surfaces which will be in contact with concrete, masonry, wood or dissimilar metals with a heavy coat of bituminous paint. Do not extend coating onto exposed surfaces.

B. Steel Exposed to View

1. SSPC 6 Commercial Shop Blast.

2. Primer and Top Coat: Shop paint Series 27 Typoxy by Tnemec; color as selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where architectural stairs are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Work in the field shall comply with the same requirements as specified for shop work above.

B. Provide connecting members needed for properly securing the work to drywall and structural framing, including bolts, machine screws, rods, hangers, inserts, sleeves, plates, anchors, expansion bolts, washers and other items as required. Furnish built-in items to drywall trades as required for proper anchorage.

C. Leave work exposed to view clean, smooth and neatly finished. All exposed welds shall be dressed smooth.

D. Include supplementary parts necessary to complete each item even though such work is not definitively shown or specified.

E. Coordinate and schedule the work of this Section with the work of other trades. Furnish anchors, sockets, fastenings and other miscellaneous items to be embedded in concrete or masonry, or required for securing metal work to other construction so as not to delay job progress.

F. Install work plumb and true to the exact lines and levels, in the correct location and in proper relation to adjoining work.

G. Touch up marred and abraded shop paint of exposed surfaces after erection in the field.

3.3 CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.4 TOUCH-UP PAINTING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop coat, and paint exposed areas with same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION

SECTION 05 73 00

EXTERIOR METAL RAILINGS

PART 1 — GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal Handrail at Monolithic Stone Steps

B. Related Sections:
1. Section 321442: MORTAR SET UNIT PAVING; Stone Tread at Monolithic Stone Steps.
2. Section 321313: LANDSCAPE CONCRETE.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A 36/A36M Standard Specification for Carbon Structural Steel.
2. A 123 Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
3. A 167 Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
4. A 312 Seamless and Welded Austenitic Stainless Steel Pipe
5. A525 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
6. A 554 Welded Stainless Steel Mechanical Tubing
7. A 743 Castings, Iron-Chromium, Iron-Chromium Nickel, and Nickel-Base Corrosion-Resistant for General Application

B. New York State Building Code:
1. Code State Building Code

C. Corps of Engineers (CE):
1. CRD-C-621 Specification for Nonshrink Grout 1 CC\05 73 00

D. American Welding Society (AWS):
1. D1.1 Structural Welding Coat – Steel
2. D1.6 Structural Welding Code – Stainless Steel
3. WZC D19.0-72 – Welding Zinc-Coated Steel

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each material used. Provide certifications stating that materials comply with requirements.

B. Shop Drawings: Shop drawings to be reviewed and accepted by Landscape Architect before construction and material purchase.
1. Show sections and plans of stairs, dimensions and assembly of components.
a. Railings
b. Handrail
c. Brackets
d. Reinforcements
e. Anchors
f. Welded and bolted connections

2. Show all field connections
3. Show anchorage and accessory items. Welding shall be indicated using AWS symbols and showing length, size and spacing (if not continuous).
4. Indicate all required field measurements.
5. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work
6. Submit one set of CAD files for approval.

C. Samples:
1. Submit duplicate samples of railing showing style and finish. One approved sample will be returned to contractor.

D. Copy of Warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm with at least three years' experience in Work of type required by this Section.

B. Welding Standards:
1. Comply with applicable provisions of AWS D1.1 "Structural Welding Code - Steel," AWS D1.3 "Structural Welding Code - Sheet Steel", and AWS D1.6 "Structural Welding Code - Stainless Steel."

2. Welder Qualifications: AWS certified for type of welding.

C. Conform to governing laws, building code, and following standards, as applicable:
1. Components and installation are to be in accordance with state and local code authorities.
2. Components and installation are to follow current ADA and ICC/ANSI A117.1 guidelines.
3. AISC Code and AISC Specification.
4. National Association of Architectural Metal Manufacturers (NAAMM), applicable publications.

D. Source: For each type of material required for Work of this Section, provide primary materials that are products of one manufacturer. Provide secondary materials that are acceptable to manufacturers of primary materials.

1.5 PERFORMANCE REQUIREMENTS

A. Handrails shall be designed to resist a lateral load of 50 pounds per linear foot (plf) applied in any direction at the top and to transfer this load through the supports to the structure.
1. Concentrated Load: Handrails and guards shall be able to resist a single concentrated load 200 pounds, applied in any direction at any point along the top, and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the uniform load specified above.

2. Components: Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot, including openings and space between rails.

3. Reactions due to this loading are not required to be superimposed with those of the previous sections.
a. Infill load and other loads need not be assumed to act concurrently.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver handrail components wrapped in manufacturer's standard protective coverings.

B. Deliver brackets, fittings, sleeves, fasteners and other miscellaneous materials and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from possible damage.

C. Sequence deliveries to avoid delays but minimize on-site storage.

1.7 PROJECT CONDITIONS

A. Field Measurements: Take accurate field measurements before preparation of shop drawings and fabrication. Do not delay job progress. Allow for field cutting and fitting where taking field measurements before fabrication is not possible. Alert Landscape Architect to any field conditions that may impede the execution of handrail construction per drawings before commencing work.

B. Weather: Perform exterior Work only when existing and forecasted weather conditions are within limits established by manufacturers of materials and products used.

C. Proceed with Work only when substrate construction is complete.

1.8 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to project site in time for installation.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Railing and components shall be as manufactured or supplied by The Wagner Companies; P.O. Box 423; Butler, WI 53007. Phone: 888-243-6914. Fax: 414-214-0550. Web site: www.wagnercompanies.com. E-mail: info@mailwagner.com. Or approved equal.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.3 MATERIALS AND FINISHES

A. Stainless Steel: Type 316
1. Bar: ASTM A 167
2. Pipe and Tubing: ASTM A 269; A 312
3. Finish: Ornamental Grade, AISI No. 4 Brushed

2.4 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
1. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated.

2.5 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.6 ANCHORING POSTS

A. Form or core-drill holes not less than 5 inches deep and 1/2 inch larger than OD of post for installing posts in stone or concrete as indicated on Drawings. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Non-shrink grout
1. Grout for adhering posts, handrail brackets and screws in masonry shall be non-shrink, non-metallic, made from factory-premixed material containing no corrosive irons, aluminums, or gypsums, meeting ASTM C1107.
2. Color to be selected from full range of manufacturer’s standard colors by Landscape Architect.

C. Exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.

2.7 ELECTROLYTIC SEPARATION/CORROSION RESISTANCE

A. Coating for electrolytic separation between steel and concrete and grout shall be a highbuild coal tar epoxy providing one coat protection for steel and concrete in a variety of chemical, immersion and underground conditions, manufactured by Tnemec Company, Inc., 6800 Corporate drive, Kansas City, MO 64120-1372; Tel. 816-483-3400; Kop-Coat Inc, 436 Seventh Avenue, Pittsburgh, PA 15219-1818; 1/412/227-2700, parent company RPM, International 2628 Pearl Road - P.O. Box 777 - Medina, Ohio 44258; Phone: 330.273.5090 - Fax: 330.225.8743; Carboline Company, 2150 Schuetz Road, St. Louis, MO 63146; Phone: 800-848-4645 or 314-644-1000; FAX: 314-644-4617, or approved equal.

2.8 FABRICATION

A. General: Fabricate railings to design, dimensions and details shown. Provide members in sizes and profiles indicated, with posts and brackets of size and spacings shown, but not less than required to support indicated structural loads.

B. Fabricate Work to be truly straight, plumb, level and square. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Cut, drill, and punch metals cleanly and accurately indicated to receive finish hardware, screws, and similar items.

D. Brackets, Flanges, Fittings and Anchors: Provide brackets, flanges, fittings and anchors as required for interconnection of guardrail components to other Work.

E. Fabricate connections that will be exposed to weather in a manner to exclude water.

F. For posts set in concrete, furnish matching sleeves or inserts not less than 5 inches long.

G. Welded Connections: Perform welding to comply with AWS for recommended practices, using method appropriate for metal and finish indicated. Grind exposed welds flush and smooth to blend with adjoining finish metal surfaces.

H. Bends: Form bends by use of prefabricated elbow fittings and radius bends, as applicable.

I. Verify dimensions on site prior to shop fabrication.

PART 3 — EXECUTION

3.1 PREPARATION

A. Examine substrates, supports, and conditions under which this Work is to be performed and notify Contractor, in writing, of conditions detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions are corrected. Beginning Work means Installer accepts substrates and conditions.

B. Verify alignment, support dimensions, and tolerances are correct.

C. Inventory components to ensure all required items are available for installation. Inspect components for damage. Remove damaged components from site and replace.

3.2 INSTALLATION

A. Install in accordance with shop drawings and manufacturer's instructions at locations indicated on the drawings.

B. Erect work square and level, parallel to rake of steps, rigid, and free from distortion or defects detrimental to appearance or performance.

C. Expansion joints shall be provided as needed to allow for thermal expansion or contraction.

D. Corrosion Protection: Provide neoprene pad, or coat concealed surfaces of metal with heavy coat of bituminous paint when metal surfaces will be in contact with grout, concrete, masonry, wood or dissimilar metals, as indicated on the Drawings.

E. Adjust railing prior to anchoring to ensure matching alignments at abutting joints. Space posts at intervals indicated, or as required by design loading.

3.3 TOLERANCES

A. The following allowable installed tolerances are allowable variations from locations and dimensions indicated by Contract Document and shall not be added to allowable tolerances indicated for other Work.
   1. Allowable Variation from True Plumb: ± 1/8 in. in 20 ft.-0 in.

2. Allowable Variation from True Level: ± 1/8 in. in 20 ft.-0 in.
3. Allowable Variation from True Line: ± 1/8 in. in 20 ft.-0 in.

3.4 CLEANING

A. As installation is completed, wash thoroughly using clean water and soap; rinse with clean water.

B. Do not use acid solution, steel wool or other harsh abrasives.

C. If stain remains after washing, remove finish and restore in accordance with NAAMM/NOMMA Metal Finishes Manual.

3.5 REPAIR OF DEFECTIVE WORK

A. Remove stained or otherwise defective work and replace with material that meets specification requirements.

B. Repair damaged finish in accordance with manufacturer's printed instructions.

C. Remove and replace Work that cannot be successfully cleaned or repaired.

3.6 PROTECTION

A. Provide temporary protection to ensure Work being without damage or deterioration at time of final acceptance. Remove protections and reclean as necessary immediately before final acceptance.

B. Protect finishes of railings from damage during construction period with temporary protective coverings approved by manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

DIVISION 06
WOOD, PLASTICS AND COMPOSITES

SECTION 062000

CARPENTRY

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the carpentry work as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Blocking and miscellaneous wood.

2. Plywood backing panels for telephone and electrical closets.

3. Plywood roof sheathing.

4. Rough hardware.

5. Installation only of finish hardware.

6. Installation only of doors and hollow metal frames.

1.3 RELATED SECTIONS

A. Architectural Woodwork - Section 064023.

B. Roofing - Section 075419.

C. Steel Doors and Frames - Section 081113.

D. Wood Doors - Section 081416.

E. Finish Hardware - Section 087100.

1.4 QUALITY ASSURANCE

A. Lumber Standard: Comply with PS 20.

B. Plywood Standard: Comply with PS 1 and American Plywood Assoc. (APA).

C. Shop fabricate carpentry work to the extent feasible and where shop fabrication will result in better workmanship than feasible for on-site fabrication.

D. Grade Marks: Identify lumber and plywood by official grade mark.

1. Lumber: Grade stamp to contain symbol of grading agency certified by Board of Review, American Lumber Standards Committee, mill number or name, grade of lumber, species grouping or combination designation, rules under which graded where applicable, and condition of seasoning at time of manufacture.

a. S-Dry: Maximum nineteen (19) percent moisture content as per ASTM D 2016.
b. MC-15 or KD: Maximum of fifteen (15) percent moisture content.

E. Installation of doors, frames and hardware shall conform to the minimum standards of "Installation Guides for Doors and Hardware" of the Door and Hardware Institute.

F. All interior millwork, wood trim and wood panels are required to be Class B flame spread.

1.5 SUBMITTALS

A. Pressure Treatment: Include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.

B. Fire-Retardant Treatment: Include certification by treating plant that treatment material complies with governing ordinances and that treatment will not bleed through finished surfaces.

1.6 PRODUCT HANDLING

A. Deliver carpentry materials to the site ready to use with each piece of lumber clearly marked as to grade, type and mill, and place in an area protected from the elements.

B. Deliver rough hardware in sealed kegs and/or other containers which shall bear labels as to type and kind.

C. Pile lumber for rough usage, when delivered to the site in stacks to insure drainage and with a minimum clearance of six (6) inches above grade. Cover stacks with tarpaulins or other watertight coverings. Store grounds and similar small sized lumber inside the building as soon as possible after delivery.

D. Do not store seasoned lumber in wet or damp portions of the building.

E. Protect fire retardant treated materials against high humidity and moisture during storage and erection.

F. Remove delivered materials which do not conform to specified grading rules or are otherwise not suitable for installation from the job site and replace with acceptable materials.

G. All items specified in Section 087100 of this specification entitled "Finish Hardware" shall be received, accounted for, stored and applied under this Section.

H. Hardware shall be sorted and stored in space assigned by Contractor and shall be kept at all times under lock and key. The safety and preservation of all items delivered will be the responsibility of the Contractor.

1.7 JOB CONDITIONS

A. Installer must examine the substrates and supporting structure and the conditions under which the carpentry work is to be installed and notify the Contractor in writing of conditions detrimental to the work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the Installer and the Architect.

B. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.

PART 2 PRODUCTS

2.1 WOOD MATERIAL

A. General

1. All wood shall be sound, flat, straight, well-seasoned, thoroughly dry and free from all defects. Warped or twisted wood shall not be used.

2. For miscellaneous wood blocking, grounds, furring as required, use Utility Grade Coastal Douglas Fir or Southern Pine, free from knots, shakes, rot or other defects, straight, square edges and straight grain, air seasoned with maximum moisture content of nineteen (19) percent. Wood shall be S4S, S-Dry, complying with PS-20.

3. Plywood

   a. For roof sheathing, provide APA Structural 1 Rated Sheathing, Exposure 1, with span rating to suit joist or truss spacing; thickness as noted on drawings.
   b. For plywood and rough carpentry at telephone and electrical closets, provide 3/4" thick C-D EXT-APA plywood, fire retardant treated as specified herein.

B. Wood Treatment

1. All interior wood material specified herein shall be fire retardant treated to comply with the AWPA standard U1 to achieve a flame spread rating of not more than 25 (UL Class "FR-S") when tested in accordance with UL Test 723 or ASTM E 84. The fire-retardant chemicals used to treat the lumber must comply with FR-1 of AWPA Standard P49 and be free of halogens, sulfates and ammonium phosphate.

   a. After treatment, kiln dry to a moisture content of fifteen (15) percent; if wood is to be painted or finished, kiln dry to a moisture content of twelve (12) percent. Treatment shall be equal to "Dricon" made by Arch Wood Protection Inc. or approved equal. Provide UL approved identification on treated materials.

2. For exterior blocking, roofing and sheet metal, pressure treat wood with copper azole, Type B (CA-B); ammoniacal copper quat (ACQ) or similar preservative product that contains no arsenic or chromium. Preservative shall comply with AWPA Standard U1, (.25 lbs./cubic foot of chemical in wood).

   a. After treatment, kiln dry to a maximum moisture content of fifteen (15) percent. Treatment shall be equal to "Wolmanized Natural Select" made by Arch Wood Protection Inc. or approved equal.

3. Treated wood which is cut or otherwise damaged shall be further treated in accordance with the AWPA Standard M-4.

2.2 HARDWARE

A. Rough Hardware for Treated Woods and Exterior Use: Hot-dipped galvanized or Type 304 stainless steel.

B. Nails: Common steel wire, untreated for interior work as per ASTM F 1667.

C. Bolts: Standard mild steel, square head machine bolts with square nuts and malleable iron or steel plate washers or carriage bolts with square nuts and cut washers conforming to the following:

1. Bolts: ASTM A 307, Grade A.

2. Nuts: ASTM A 563.

3. Lag Screws and Bolts: ASME B 18.2.1.

D. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material for Treated Woods and Exterior Use: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2. Material for Other Uses: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

E. Wood Screws: ASME B 18.6.1.

F. Concrete and Masonry Anchors: Standard expansion-shield self-drilling type concrete anchors where so shown or noted on the drawings, or where approved by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where carpentry is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION OF FINISH HARDWARE

A. Hardware shall be carefully fitted and securely attached, in accordance with these specifications and the instructions of the various manufacturers.

B. Unless otherwise noted, mount hardware units at heights established in Section 081113.

C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units which are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

F. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. All keys used shall be construction keys which are to be tagged with fiber discs as approved, clearly labeled with identifying inscriptions and then neatly arranged in a temporary cabinet. All construction keys shall be returned to the Owner.

H. Adjusting and Cleaning

1. Adjust and check each operating item of hardware and each door, to ensure proper operation and function of every unit. Lubricate moving parts with type lubrication recommended by manufacturer

(graphite type if no other recommended). Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.

2. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean and re-lubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.3 INSTALLATION OF DOORS AND FRAMES

A. Preparation

1. Remove welded-in shipping spreaders installed at factory.

2. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

3. Drill and tap doors and frames to receive non-templated mortised and surface-mounted door hardware.

B. Installation

1. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

2. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

   a. Install frames in accordance with ANSI/SDI A250.11, Recommended Erection Instructions for Steel Frames, unless more stringent requirements are specified herein.
   b. At fire-protection-rated openings, install frames according to NFPA 80.
   c. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   d. Install frames with removable glazing stops located on secure side of opening.
   e. Frames set in masonry walls shall have door silencers installed in frames before grouting.
   f. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   g. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

3. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with post-installed expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

4. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames conforming to the requirements of Section 072100 "Thermal Insulation."

5. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

6. Installation Tolerances: Adjust steel door frames for squareness, alignment, twist, and plumb to the tolerance given in HMMA 841 of ANSI/NAAMM, current edition.

7. Steel Doors: Fit hollow metal doors accurately in frames to the tolerances given in HMMA 841 of ANSI/NAAMM, current edition.

a. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

8. Glazing: Comply with installation requirements in Section 088000 "Glass and Glazing" and with standard steel door and frame manufacturer's written instructions.

a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

C. Wood Doors

1. Condition doors to average prevailing humidity in installation area prior to hanging.

2. Install doors in accordance with manufacturer’s instructions.

3. Fit door to frames and machine for hardware to whatever extent not previously worked at factory as required for proper fit and uniform clearance at each edge.

4. Clearances: Install doors to meet clearance requirements specified in Section 081416.

5. Fire-Rated Doors: Install in corresponding fire-rated frames in accordance with the requirements of NFPA No. 80. Provide clearances complying with the limitations of the authority having jurisdiction.

D. Adjustments: Check and readjust operating finish hardware items just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise unacceptable.

3.4 BLOCKING AND MISCELLANEOUS WOOD

A. General

1. Erect rough carpentry true to line, levels and dimensions required; squared, aligned, plumbed, and securely fastened in place.

2. Shim where required to true up furring, blocking and the like. Use wood or metal shims only.

3. Do all cutting, fitting, drilling and tapping of other work as required to secure work in place and to perform the work included herein. Do all the cutting and fitting of carpentry work, for the work of other trades as required.

B. Blocking and Miscellaneous Wood

1. Furnish and install all wood grounds, furring, blocking, curbs, bucks, nailers, etc., that may be necessary and required in connection with the carpentry and with the work described for any other trades and including required carpentry for electrical fixtures. All blocking and nailers shall be continuous wherever required, whether or not so indicated.

2. Blocking shall be as required for the proper installation of the finished work and for items in mechanical sections as required. Blocking, edgings, stops, nailing strips, etc., shall be continuous, unless distinctly noted otherwise. Provide blocking as required to install all equipment. Provide blocking and nailers where shown or required to fasten interior sheet metal work.

3. Blocking within Wall Construction: For blocking used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

4. Fastening for wood grounds, furring and blocking shall be of metal and of type and spacing as best suited to conditions. Hardened steel nails, expansion screws, toggle bolts, self-clinching nails, metal plugs, inserts or similar fastenings shall be used, of suitable type and size to draw the members into place and securely hold same.

C. Rough Lumber for Roofing and Sheet Metal

1. Furnish and install all wood nailing strips and wood blocking required in connection with respective types of roofing, fans, flashings, and sheet metal work, using preservative treated wood as herein before specified.

2. Wood blocking shall be of sizes and shapes as indicated on the drawings and/or designed for the reception of curb flashings for roof ventilators and similar items.

3. All nailing strips and blocking shall be carried out in accordance with the printed installation instructions, and/or recommendations of the accepted manufacturer of the roofing materials, and in coordination and cooperation with the sheet metal work trades.

4. All blocking and nailing strips shall be firmly secured in place using counter bored bolt and nut fastenings or secured by any other proposed flush surfaced fastenings.

5. Wood nailing strips or blocking required to be embedded in concrete work shall be furnished in time due for placing, prior to start of concrete operations. Locations and spacings of nailing strips or blocking shall be performed in coordination with the concrete trades, as required for respective installations.

3.5 PLYWOOD ROOF SHEATHING

A. Install plywood roof sheathing with long dimension across supports, using panels continuous over 2 or more spans with end joints between panels staggered and located over center of supports.

1. Nail 6" o.c. along panel edges and ends and 12" o.c. at intermediate supports for spans less than 48" using 6d common nails for panels 1/2" or less, 8d common nails for panels over 1/2" but less than 1" thick, and 8d ring shank or spiral thread nails or 10d common nails for panels 1" or more thick. For spans 48" or greater, space nails 6" o.c. at all supports.

2. Provide support at unsupported long edges with "Plyclips" or wood blocking.

B. Allow 1/8" open space between end joints and 1/4" open space between edge joints for expansion and contraction of panels.

3.6 TELEPHONE AND ELECTRICAL EQUIPMENT MOUNTING BOARDS

A. Furnish and install 3/4" thick plywood panels to the walls of the telephone and electrical equipment rooms in accordance with the requirements of the local utility company.

B. Secure to wall using proper devices for substrates encountered, spaced twelve (12) inches o.c., maximum around the edges, 1-1/2" from corners, and in three (3) rows of three (3) each in the field. Recess fastening devices flush with the plywood surface. Adjacent panels shall be butted with 1/16" space between without lapping.

3.7 ROUGH HARDWARE

A. Securely fasten rough carpentry together. Nail, spike, lag screw or bolt as required by conditions encountered in the field and the Contract Documents.

B. Provide rough or framing hardware, such as nails, screws, bolts, anchors, hangers, clips, inserts, miscellaneous fastenings, and similar items of the best quality and of the proper size and kind to adequately secure the work together and in place, in a rigid and substantial manner.

C. Secure rough carpentry to masonry with countersunk bolts in expansion sleeves or other acceptable manner, with fastenings not more than sixteen (16) inches apart. Secure woodwork to hollow masonry with toggle bolts spaced not more than sixteen (16) inches apart.

D. Countersink bolts in nailers and other rough woodwork and include washers and nuts. Cut bolts off flush with surfaces and peen as may be required to receive finished work.

E. Inserts to secure wood nailers to concrete shall be malleable iron threaded inserts with 3/8" diameter bolts of length to allow for countersinking. Locate at end of each nailer and at intervals not exceeding thirty (30) inches o.c.

F. Furnish to the mason for building into the work, or attaching the work which is to be built in, anchors, bolts, wall plates bolted to masonry, corrugated wall plugs, nailing blocks, etc., which are required for the proper fastening and installation for the work or other items as called for in this Section.

G. Detailed instructions with sketches of necessary requirements, shall be given to the masonry trade showing the location and other details of such nailing devices.

3.8 CLEANING UP

A. General: Keep the premises in a neat, safe and orderly condition at all times during execution of this portion of the work, free from accumulation of sawdust, cut-ends and debris.

B. Sweeping

1. At the end of each working day, or more often if necessary, thoroughly sweep all surfaces where refuse from this portion of the work has settled.

2. Remove the refuse to the area of the job site set aside for its storage.

3. Upon completion of this portion of the work, thoroughly broom clean all surfaces.

END OF SECTION

SECTION 064023

ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the architectural woodwork as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Interior and exterior tongue-and-groove wood ceilings.
2. Interior and exterior wood ceilings - Resawn.
3. Clear (oak) and painted wood paneling; refer to Material Schedule.
4. Wood paneling and wainscots.
5. Wood trim, moldings and bases.
6. Wood door frames and jambs.
7. Wood railings.
8. Wood millwork and counters with wood veneers.
9. Wood millwork and counters with plastic laminate finish.
10. Hardware for architectural woodwork.
11. Shelving and closet specialties.
12. Solid surfacing material countertops.
13. Wood framing and rough lumber as required for work of this Section.
14. Wood grounds, blocking, nailers, furring as required for work of this Section.
15. All rough hardware and fastenings for work of this Section.
16. Drilling concrete and masonry, drilling and/or tapping metal work, as required, for the installation of work of this Section.
17. Back painting as specified herein.
18. Shop finishing of work of this Section, except items indicated herein to be shop primed only.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000.

B. Caulking between architectural woodwork and any wall, floor, or ceiling joints - Section 079200.

C. Wood Doors - Section 081416.

D. Field finishing of architectural woodwork - Section 099000.

E. Stone Countertops - Section 123640.

F. Engineered Quartz Countertops - Section 123661.

1.4 QUALITY STANDARDS

A. The quality standards of the Architectural Woodwork Institute, "Architectural Woodwork Standards" (AWS), 2nd Edition, dated July 1, 2016, shall apply to all workmanship, including materials and installation, for architectural woodwork, and by reference are made a part of this specification. All work shall conform to "Premium" grade requirements of the AWS unless otherwise modified herein.

B. In the event of a dispute as to the quality grade (or grades), the Contractor shall call upon the Architectural Woodwork Institute for an inspection under AWI's Quality Certification Program which shall include a QCP Inspection and Report. The Contractor agrees to abide by the decision of this Report. The cost of said inspection and report shall be borne by the Contractor.

C. Employ only tradesmen experienced in the fabrication and installation of architectural woodwork.

D. Woodworking firm must be accredited by the AWI Quality Certification Program (QCP).

1.5 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings of all woodwork specified and indicated on the drawings. Shop drawings shall indicate room plans and elevations at 3/4" equals 1'-0" scale and typical construction details at 3" equals 1'-0" scale. Shop drawings shall indicate all materials, thicknesses and finishes.

2. Shop drawings shall show all finish hardware, anchors, fastenings and accessories.

3. Shop drawings shall show all jointing, joint treatment and butt jointing in veneers and plastic laminate.

4. Shop drawings for wood paneling must show complete elevations of rooms to receive paneling as well as panel matching required by these specifications.

5. Shop drawings for cabinet work must show centerline height and horizontal location of all required internal wall blocking.

6. Where architectural woodwork deviates from AWI standards noted herein, shop drawings must identify these deviations.

B. Samples: Submit samples of each of the following items:

1. Plastic laminate, twelve (12) inches square, including a section of outside corner.

2. Transparent finish for each species of wood veneer laminated to particleboard, twelve (12) inches square, for each finish specified or shown.

   a. Submit sample of clear matte finish, "Decorator's Varnish" by Polyvine, dead flat finish, or similar water-resistant clear matte sealer.

3. Opaque finish wood veneer laminated to particleboard, twelve (12) inches square for each color, gloss and finish specified or shown.

4. Each finish type of wood panel, 24" wide x 36" high.

5. Each type and finish of each type of wood cornice, trim, molding, etc., eight (8) inches long, finish as specified.

6. Cabinet hardware.

1.6 QUALIFICATIONS

A. The work of this Section shall be provided by a firm having a minimum of five (5) years' experience on projects of similar size and quality to that specified and shown.

1.7 COORDINATION

A. Coordinate the work of this Section with other appropriate Sections of the specifications to insure proper scheduling for fabrication and installation of the work specified herein.

B. Coordinate with partition and finish trades to insure that proper provisions are made for the installation of the work specified herein.

C. Verify all dimensions in the field prior to fabrication of all Architectural Woodwork to assure proper fit.

1.8 PRODUCT HANDLING

A. All materials and work of this Section shall be protected from damage from time of shipment from shop to final acceptance of work. Cover, ventilate, and protect work of this Section from damage caused by weather, moisture, heat, staining, dirt, abrasions, any other causes which may adversely affect appearance or use, or which may cause deterioration of finish, warping, distortion, twisting, opening of joints and seams, delamination, loosening, etc., of work of this Section.

B. Keep all finish carpentry, millwork, and cabinet work under cover both in transit and at the premises. Do not deliver any finish carpentry, millwork or cabinet work before it is required for installation. Protect such work to avoid damage in transit, during erection and after erection until acceptance of the building; use all such methods to provide the proper protection. Remove such protection when directed by the Architect.

C. Deliver finish carpentry, millwork, and cabinet work in a dry stable condition; protect same against injury and dampness. Do not store or install finish carpentry, millwork or cabinet work until after the concrete, masonry and plaster work are thoroughly dry.

D. Damaged or defective items of work of this Section are subject to rejection and replacement with new by Contractor, at no cost to Owner.

1.9 JOB CONDITIONS

A. Humidity Controls: The ambient relative humidity at the site, including both the storage and the installation areas, shall be maintained between 25% and 55% prior to delivery and through the life of the installation.

B. Determine equilibrium moisture content and maintain required temperature and relative humidity as required for a tolerance of plus or minus one (1) percent of the specified optimum moisture content until woodwork receives specified finishes. Refer to "Guide to Wood Species Selection," AWI, for method of determining equilibrium moisture content values.

C. Examination of Substrate and Conditions: The installer must examine the substrate and the conditions under which the work of this Section is to be performed, and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with work under this Section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

D. Areas to receive architectural woodwork must be fully enclosed with windows and/or curtain wall installed and glazed, exterior doors in place, HVAC systems operational, and temporary openings closed. Any plaster, wet grinding and concrete work shall be fully dry.

E. Architectural woodwork shall be allowed to come to equilibrium on site for 7 days prior to installation.

PART 2 PRODUCTS

2.1 BASIC REQUIREMENTS

A. Wood Moisture Content: Provide kiln-dried (KD) lumber with an average moisture content range of nine (9) to twelve (12) percent for exterior work and six (6) to eleven (11) percent for interior work.

B. Measurements: Before proceeding with woodwork required to be fitted to other construction, obtain field measurements and verify all dimensions of shop drawing details as required for accurate fit.

C. Compatibility of Grain and Color: Architect reserves the right to select materials for best compatibility between visually related members and veneers.

D. Machine and sand woodwork to comply with requirements of Standards for specified grade.

E. Fabricate woodwork to dimensions, profiles and details shown. Rout or groove back of flat trim members, kerf backs of other wide flat members except plywood or veneered members.

F. Miter joints by joining, splining and gluing to comply with requirements for the specified grade.

G. Inspect each piece of lumber and plywood or each unit of woodwork after drying; do not use twisted, warped, bowed or otherwise damaged or defective wood.

H. All interior millwork, wood trim and wood panels are required to be Class B flame spread.

2.2 GENERAL - MATERIALS

A. Softwood lumber shall conform to the requirements of the latest edition of American Lumber Standards Simplified Practice Recommendation R-16. Grades shall conform to the grading rules of the Association having jurisdiction, and shall bear the official grade and trademark of the Inspection Bureau of the Association and a mark of mill identification.

B. Framing and Rough Lumber: No. 1 KD grade Southern Pine or Dense Construction grade Douglas Fir, having extreme fiber in bending stress of at least 1700 psi, surfaced four sides (S4S). Provide fire retardant treatment meeting requirements of Section 062000.

C. Grounds, Blocking, Nailers, Furring: Southern Pine, Douglas Fir or Sitka Spruce, grade to suit particular purpose and to be straight, square edged, straight grained, surfaced four sides (S4S), and which will retain nails and screws without splitting. Provide fire retardant treatment.

D. Wood Veneers and Lumber: Provide AWI Premium Grade materials and workmanship. For species not listed in the AWS comply with the following:

1. Provide AWS Lumber Grade Premium and AWS Grade AA Veneer, book-matched, minimum 6 inch face veneer width. Kiln dry to 6-8 percent moisture content. Components shall be free of defects and sapwood. Match adjacent pieces for color and grain pattern.

2. Single-Source Requirement for Wood Veneers and Solids: Intent is to provide wood which matches as closely as possible throughout the project. Provide wood veneers and solids from the same distributor, and from the same flitches and solids sources to the greatest extent possible.

E. Lumber: AWS Section 3 with the following requirements:

1. Hardwood for Transparent Finish: Premium Grade, select species and cut to match adjoining veneers, unless otherwise shown or specified, and free from cat's eyes, bird's eyes, burls, curls or cross grains.

2. Hardwood for Opaque Finish: Any hardwood which, when finished, will not show any grain, imperfection or other surface defects when used with the opaque finish specified.

F. Plywood: AWS Section 4; veneer core, particleboard or plywood core unless otherwise specified, and with the following requirements:

1. Hardwood: Premium Grade, face veneers as shown or specified.

2. Particleboard: Premium Grade, fire retardant for wall paneling only equal to Duraflake FR and Duraflake for cabinets. Particleboard shall be certified to meet EPP CPA 3-08 formaldehyde emission limit of 0.18 ppm, and contain no added formaldehyde resins.

3. Medium-Density Fiberboard (MDF): Conforming to ANSI A208.2, Grade 130 and ANSI MR10 moisture-resistant properties on 5/8" or thicker board. MDF shall be certified to meet EPP CPA 3-08 formaldehyde emission limit of 0.21 ppm, and contain no added formaldehyde resins.

4. Edges: 1/8" thick edging. Banded with hardwood in accordance with Premium Grade Standards.

G. Wood Species and Cut for Transparent Finish: Quarter sliced/sawn, species as selected by the Architect.

1. Match Architect's control samples for transparent finish, veneer grain and figure characteristics.

H. Veneer Matching Requirements:

1. Matching Between Adjacent Veneer Leaves: Book match and architectural end match.

2. Matching Within Individual Panel Faces: Balance and Center Match.

3. Method of Matching Panels: Blueprint-matched panels and components.

I. Finishing (Wood)

1. Transparent Finish

a. AWI Factory Finish System "Conversion Varnish, System 5, Transparent."
b. AWI Premium Grade.
c. Stain: As selected by the Architect.
d. Degree of Sheen: Clear matte ("Decorator's Varnish" by Polyvine or equal, dead flat finish).

2. Opaque Finish

a. AWI Factory Finish System "Conversion Varnish, System 5, Opaque."
b. AWI Premium Grade.
c. Degree of Sheen: Satin.
d. No grain to show.

3. Natural woods shall have open pores, as noted on the Finish Schedule.

2.3 PLASTIC LAMINATE

A. Face Sheets: NEMA Publication LD3, Grade GP50, Type I, 0.05" thick, as manufactured by Formica, Nevamar, WilsonArt. Color, pattern and finish as selected by the Architect.

B. Backing Sheets: Non-decorative, high-pressure plastic laminate, NEMA LD3, Grade BK20, 0.02" thick.

C. Edges: Finish with 1/8" thick edging, plastic laminate to match face and applied before face sheets are applied, unless otherwise shown or specified.

2.4 METAL

A. Steel

1. Structural Steel Shapes and Plates: ASTM A 36.

2. Hot-Rolled Carbon Steel Sheets: Commercial quality, ASTM A 569, may be used for concealed parts only. Galvanize sheets for planters.

B. Primer for Unexposed Metal: Zinc chromate primer.

2.5 GLASS

A. Glass used in architectural woodwork shall be tempered, complying with the requirements of Section 088000.

2.6 MISCELLANEOUS PRODUCTS

A. Fasteners

1. Wood Screws: FS FF-S-111, type, size, material and finish as required for the condition of use.

2. Nails: FS FF-N-105, type, size, material and finish as required for the condition of use.

3. Anchors: Type, size, material and finish as required for the condition of use.

4. Staples: Upholstery type staples of sufficient strength to hold fabric taut in place without sagging.

B. Adhesives

1. For Laminating Plastic Laminate Surfaces: Urea resin, Type II, as recommended by fabricator.

2. For All Other Uses: Polyvinyl acetate resin emulsion or other type as recommended by the fabricator.

2.7 CABINETS WITH PLASTIC LAMINATE FINISH

A. General

1. Fabricate all cabinetry and millwork to the "Premium Grade" standards of the AWS, Section 10.

2. Face construction of cabinets shall be "Flush Overlay."

3. Provide 3/4" thick doors, drawer fronts and fixed panels (including thickness of plastic) except where required to be thicker by Standards; and provide flush units.

4. Provide dust panels of 1/4" thick plywood or tempered hardboard above compartments and drawers, except where located directly below countertops.

5. Exposed Edges: Plastic laminate matching exposed panel surfaces. Ease exposed edge of overlap sheet.

B. Plastic Laminate

1. Plastic Laminate for Horizontal Surfaces: 0.050" thick, general purpose type (high pressure).

2. Plastic Laminate for External Vertical Surfaces: 0.028" thick, general purpose type (high pressure).

3. Plastic Laminate for Post Forming: 0.042" thick, post forming (high pressure).

4. Plastic Laminate for Cabinet Linings: 0.020" thick, cabinet liner (high pressure).

5. Plastic Laminate for Concealed Panel Backing: 0.020" thick, backer type (high pressure).

6. Plastic Laminate Colors and Patterns: As selected by the Architect from manufacturer's standard satin finish products.

C. Shop Assembly: All work shall be shop assembled. Work that is too large for entrance into the use area shall be fabricated in attachable sections with provisions for reconnection in the using space.

D. Material Thicknesses: See drawings for general material thicknesses. Minimum thickness of solid lumber for web frames, trim, bases, etc., shall be 3/4". Minimum thickness of plywood and particleboard shall be 3/4".

E. Sizes: See drawings for woodwork sizes required. The manufacturer shall check field dimensions and verify all openings and actual field conditions prior to fabrication of work.

F. Manufacturer is responsible for rigidity and structural stability.

2.8 PLASTIC LAMINATE COUNTERTOPS

A. Grade: Same as AWI grade required for cabinet work; plastic laminate finish.

B. Construction

1. Provide back-splash and end-splash, where detailed; top-mounted square butt joint, fully covered with matching plastic laminate, eased edges.

2. Exposed Counter Edges: Plastic laminate matching surface, except as otherwise indicated. Ease exposed edges of overlap sheet.

3. Cut openings for equipment to be installed. Comply with equipment manufacturer's requirements, but provide internal corners of 1/8" minimum radius. Smooth saw cut and ease edges.

4. Seal cut edges of counter at openings for sinks and other "wet" equipment, using waterproofing compound recommended by plastic manufacturer and compatible with laminating adhesive.

2.9 BUILT-IN CABINETS, WOODWORK WITH WOOD VENEER FINISH

A. Construction: Details of cabinet and woodwork construction shall conform to design as detailed on the drawings and shall be constructed in accordance with AWS Section 10, Premium Grade.

B. Finishing: All work shall be factory pre-finished. No field finishing will be permitted, except minor retouching that is necessary after installation to leave work in perfect condition. Field touch-up shall be accomplished using the same finishes as originally applied at the factory. All finishes shall be free from runs, sags and other visual defects. All wood shall be thoroughly hand smoothed and hand sanded to remove all traces of machine and tool marks. All steel or other metal components shall be deburred, thoroughly cleaned and degreased prior to finishing. Requirements for surface preparation shall be in accordance with AWI Standards specified. Surfaces shall be finished as follows:

1. Wood Species and Cut for Exposed Surfaces: As specified hereinabove.

   a. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
   b. Matching of Veneer Leaves: Book match.
   c. Vertical Matching of Veneer Leaves: End match.
   d. Veneer Matching within Panel Face: Running match.
   e. Veneer Matching within Room: Provide casework veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.

2. Semi-Exposed Surfaces: Provide surface materials indicated below:

   a. Surfaces Other Than Drawer Bodies: Compatible species to that indicated for exposed surfaces, stained to match.
   b. Drawer Sides and Backs: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
   c. Drawer Bottoms: Hardwood plywood.

3. All wood veneer surfaces shall be given transparent finish as specified herein.

4. Backing Veneer: Provide backing veneer, of same thickness and strength as face veneer for balanced construction, where plywood surface not exposed, not semi-exposed, or not to be finished. Note that interior surface of cabinets, closets, are to be finished.

C. Edge Banding: All visible edges of case and body members fabricated from plywood shall be banded. Transparent finished wood veneer panels shall be banded with wood species to match face veneers; 1/8" thick.

2.10 HARDWARE

A. Architectural Woodwork Hardware: Provide the following items, or their approved equal, as required, as scheduled on the drawings:

1. Hinges: Concealed hinges.

2. Catches: Magnetic; top and bottom.

3. Pulls: Selected by the Architect.

4. Locks: Directed by the Architect.

5. Drawer Slides: Full extension, 100 lb. capacity.

6. Shelf Supports: Pin and grommet system.

7. Finish: As scheduled on the drawings.

B. Closet Hardware: Oval wardrobe rails, chrome-plated steel with center bracket and wall-support brackets made by Hafele, or approved equal.

2.11 WOOD FOR RAILINGS, TRIM, BASES, MOLDINGS AND FRAMES

A. Quality Standard: For the following types of interior architectural woodwork, comply with indicated standards as applicable.

1. Standing and Running Trim: AWS Section 6.

2. Miscellaneous Millwork: AWS Section 6.

3. Stair Handrails: AWS Section 7.

B. Woodwork for Transparent Finish: Except as otherwise indicated, comply with the following:

1. Grade: Premium.

2. Species of Solid Wood: Quarter Sawn Species as noted on drawings.

C. Woodwork for Paint Finish: Except as otherwise indicated, comply with the following:

1. Grade: Premium.

2. Species of Solid Wood: Solid, paint grade, sound clear Poplar or Birch.

2.12 HARDWOOD VENEERED PLYWOOD PANELS

A. Type: Interior grade, hot press laminated with waterproof adhesive, pre-finished, with face veneers and core construction as specified herein, meeting AWS Section 8 standards.

B. Core Construction: Shall be fire retardant treated, meeting requirements of Section 062000; type at fabricator's option.

1. Where the core is free of urea formaldehyde, provide a layer of veneer over the substrate prior to application of finish veneer to prevent telegraphing of patterns of the adhesive.

C. Thickness: 3/4" thick.

D. Face Veneers: Panels shall be flitch matched, sequence matched, book matched, end matched, center balanced, rift sliced, vertical grain, and shall be matched for color. Wood species shall be as indicated. Use this veneer in all other areas where wood paneling is required. All panels shall be matched one to the other using "blueprint" matching method. Veneer shall be minimum 1/28" thick.

E. Finish: Veneers shall be finely sanded and clear factory pre-finished using AWI System noted herein.

F. Panel Sizes: See drawings for panel sizes required.

G. Exposed edges of panels shall be solid sections matching face veneer.

H. Where wood doors are set in veneered wood paneling, veneer on door shall be sequenced to fit veneer pattern; doors to meet the requirements of Section 081416.

2.13 SOLID SURFACING MATERIAL COUNTERTOPS

A. Engineered Quartz Surfacing: Provide 1-1/4" thick quartz stone surfacing as manufactured by CaesarStone Quartz Surfacing, or approved equal.

1. Color: See Finish Schedule

2. Finish: Polished on all exposed surfaces unless otherwise indicated.

3. Exposed Edges and Corners

a. Edges: Square. Miter joint with 1/8" diameter eased edge profile at countertop fascia.
b. Outside Corners: Square.

4. Anchors and Fastening Devices: Fabricate from AISI Type 304 stainless steel, No 4 finish.

5. Fire Test Results (ASTM E 84):

a. Flame Spread Index: Class A Rating (20).
b. Smoke Developed Index: Class A Rating (110).

2.14 FABRICATION - GENERAL

A. Provide lumber framing for architectural woodwork, complete with all bracing and fastening devices as required for a rigid installation, and as required to sustain the imposed loads.

B. Do all fabrication from field measurement with provision for scribing as required to meet built-in conditions.

C. Coordinate the work of this Section with the work of other trades.

D. Fabricate units in largest practicable sections. Assemble in the shop for trial fit, disassemble for shipment and reassemble with concealed fasteners.

E. Maintain relative humidity and temperature during fabrication, storage and finishing operations matching that of the areas of installation.

F. Details indicate the required type and quality of construction. Modifications to conform to manufacturer's standards will be considered provided that they comply with the Contract Documents and maintain the profiles shown, subject to acceptance by the Architect.

G. Reinforcing shown is minimum. Provide additional reinforcing as required to ensure a rigid assembly. Exposed surfaces shall be free from dents, tool marks, warpage, buckle, glue and open joints, or other defects affecting serviceability or appearance. Accurately fit all joints, corners and miters. Conceal all fasteners. Make threaded connections up tight so that threads are entirely concealed.

H. Factory finish all items where possible. Defer final touch-up, cleaning and polishing until after delivery and installation.

I. Comply with AWI, Premium Grade, for sanding, filling countersunk fasteners, back priming and similar preparations for the finishing of architectural woodwork, as applicable to each unit of work.

J. Prepare all countersunk wood screw attachments for wood plugs. Wood plugs shall match surrounding species and grain direction; putty filling is not acceptable.

2.15 FABRICATION - SPECIFIC ITEMS

A. Millwork

1. Include all preparations for mechanical, electrical, telephone and plumbing work required.

2. Provide cabinet hardware for millwork as shown.

3. Provide dust panels in body webs and between drawer units.

4. Provide wood veneers for exposed surfaces as specified herein before.

5. Hollow core doors will not be permitted.

6. Provide matching veneers for edge treatments of case body members where transparent finishes are indicated or specified.

7. Provide drawers with slides as specified. Drawers shall not rest on web body frames.

8. Provide wood veneers for transparent finish, of matching and continuing grain, for drawer and door edges.

B. Paneling

1. General Paneling Requirements

a. Panel type shall be AWI, Premium Grade construction.
b. Panel joints shall be flush type unless otherwise shown.
c. Provide concealed wood blocking and framing, anchors, clips, splines, supporting and attaching devices.
d. Provide cut-outs to receive attachments, mechanical and electrical work as required.

2. Wood Veneer Paneling

a. Comply with AWI Section 8.
b. Provide veneers as specified and as shown, including all matching requirements. Run veneer in the direction shown.

3. Stile and Rail Paneling

a. Comply with AWI Section 8.
b. All exposed edges of panel cores shall be edge banded.
c. Grain direction shall be as shown.

C. Closet and Storage Shelving

1. Provide closet and storage shelving in accordance with AWI, Custom Grade, unless otherwise shown or specified.

2. Exposed edges shall have hardwood edge bands.

D. Standing and Running Trim: Provide standing and running trim of the sizes, profiles, species and finish as specified or shown and complying with AWI Section 6, Premium Grade.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where architectural woodwork is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 FRAMING

A. Use specified framing lumber, sizes and spacing as indicated on drawings and as required to support loads.

B. Framing shall be cut square on bearings, closely fitted, accurately set to required lines and levels, rigidly secured in place at bearings and connection with nails, lag screws and/or bolts as required by conditions.

3.3 GROUNDS, BLOCKING, NAILERS AND FURRING

A. Provide all wood grounds, blocking, nailers, furring, and the like for work of this Section, where shown and where required, dressed to size indicated or required to suit the condition. Install grounds, blocking, nailers, furring, etc., rigidly, in proper alignment, trued with a long straight edge.

3.4 ROUGH HARDWARE

A. Provide all rough hardware, such as nails, screws, bolts, anchors, hangers, clips and similar items. Hardware shall be of the proper size and kind to adequately secure the work together and in place, in a rigid and substantial manner. Use galvanized hardware at exterior walls, and at other locations where subject to moisture or where water will be present.

B. Secure wood to concrete and to solid masonry with countersunk bolts in expansion sleeves or other approved manner, to steel with countersunk bolts, to hollow masonry and to drywall with heavy duty countersunk toggle bolts. Space fastenings not more than sixteen (16) inches apart. Hardened cut nails, power-driven fastenings, or other suitable devices may be used where approved by the Architect.

C. Connections and fastenings shall be made in such manner as will compensate for swelling and shrinkage and shall permit the work to remain permanently in place without any splitting or opening of joints.

3.5 INSTALLATION OF CABINET FINISH HARDWARE

A. All items of finish hardware furnished under this Section shall be carefully fitted and secured in place as part of the work of this Section. Locations and positioning of hardware shall be subject to the Architect's approval. Care shall be taken not to mar or damage hardware, or other work. Install doors plumb and true. Hardware shall be fitted to assure operation without forcing.

B. After preliminary fitting of hardware, the Contractor shall remove trim for painting and finishing work; after which he shall reinstall the hardware in a permanent manner.

C. Upon completion of the work, before final acceptance of the building by the Owner, the Contractor shall, in the presence of the Architect, show that all hardware is in satisfactory working order; fit all keys in their respective locks and, upon acceptance of the work, shall tag and deliver all keys to the Architect and Owner.

D. When directed by the Owner, at any time during the first year after the completion of the Contract, the Contractor shall return to the building and adjust and refit the work and hardware, and leave such items in satisfactory working order.

3.6 GENERAL INSTALLATION

A. Wall anchorage and general installation procedures for cabinetry work shall conform to AWS Section 10, Article entitled "EXECUTION," Sub-Article 6.1, with all related sub-paragraphs.

B. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8" in 8'-0" for plumb and level (including countertops), and with 1/16" maximum offset in flush adjoining surfaces, 1/8" maximum offset in revealed adjoining surfaces.

C. Scribe and cut work to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation.

3.7 TRIM, MOLDINGS, ETC.

A. Install with minimum number of joints possible, using full-length pieces for each run. Stagger joints in adjacent and related members. Cope at returns, miter corner.

B. Joints of all trim and/or moldings shall be set tight, miter exterior angles and cope interior angles. Joints, except end joints less than twelve (12) feet apart, will not be permitted in straight runs of trim and/or moldings and rails.

C. Secure all trim and/or moldings with glue and blind nail with finishing nails. Set exposed nail heads in finished work and putty. Sand all work to remove any tool marks and irregularities.

D. Wood shall receive finish as specified in Section 099000, "Painting and Finishing."

3.8 WOOD HANDRAILS

A. Wood shall be planed straight, square and level, then sanded smooth with flush finished surfaces. Joints shall occur over supports. Right angle joints shall be mitered.

B. All exposed fastening devices shall be countersunk and set below finished wood surfaces, and fitted with matching wood plugs; sand plugs and finish smooth and flush with exposed surfaces.

C. Handrails shall be capable of withstanding a force of two hundred (200) lbs. applied to rail at any point from any direction.

D. Provide all hardware and metal supports required for complete installation as detailed on drawings.

3.9 VENEERED WOOD PANELS

A. Provide a system of concealed panel hanger clips, shims and corresponding wall clips to support the panel system. Face nailing shall not be permitted.

B. Hang the panels in the designated locations. Panels shall be straight, level, flat and flush with adjoining panels.

C. Where reveals are indicated, keep panels spaced so that reveals are parallel and of widths shown.

3.10 CLOSET AND STORAGE SHELVING

A. Provide closet and storage shelving at the locations shown. Provide hang rods where shown. Set adjustable center hangers.

3.11 CABINET WORK AND MILLWORK

A. General

1. Materials and workmanship shall conform to the Quality Standards of the Architectural Woodwork Institute specified herein and to the drawings.

2. Cabinet work and millwork shall be performed by an experienced cabinet work and millwork company, having craftsmen skilled in their trade.

3. Fabricate all cabinet work and millwork completely in the shop, in complete and/or as large units as practical, leaving only fitting, assembly, installation and a minimum of fabrication and finishing to be done at the building. Assembled work shall be rigidly secured and permanently fastened together with concealed fasteners.

4. Afford Architect every facility for inspection of work at shop or mill at such times as the Architect may select.

5. As far as practicable, use concealed fastenings for joining and assembling the work. Where this is impossible, the means of securing shall be placed in inconspicuous places and methods of joining and assembling submitted for Architect's approval prior to fabrication.

6. Mill all finish wood accurately to detail, with clean cut moldings, profiles and lines, machined, sanded smooth, housed, jointed, blocked, put together in the best manner, with provision for swelling and shrinkage, and to assure the work remaining in place without warping, splitting or opening of joints.

7. Cut trim to dimensions and profiles shown, from solid stock.

8. Make all trim and the like in single lengths wherever possible; joints mitered, glued and splined. Continuous members shall have tight flush joints, doweled or splined and glued.

9. Make all joints hairline tight, fitted accurately and joined with hardwood splines or dowels, glued together, or by other method approved by Architect. Use screws, not nails, for fastenings.

10. Gluing shall, where practicable, be by the hot plate press method and glued surfaces shall be in close contact throughout. Glue stains on finished work will not be permitted.

11. Cover surface fastenings, where permitted, with matching wood plugs or wood putty. Finish exposed edges of plywood with matching solid stock. Lock miter external corners; tongue and groove internal corners to allow for contraction and expansion.

12. Machine sand with grain, finish with hand sanding, leave exposed surfaces free from machine or tool marks that will show through the finish.

13. Work which adjoins drywall, concrete, or other finish shall be fitted and scribed in a careful manner and ample allowance shall be given for cutting and scribing.

14. Erect work true to lines, levels and dimensions, square, aligned and plumb, securely and rigidly fastened in place.

B. Cabinet Work: Provide all items of cabinet work indicated on drawings and as herein specified.

1. Tops, sides, backs, bottoms, dividers, shelves, fronts, doors and drawer fronts shall be of plywood or flakeboard core, with the specified wood veneer or plastic laminate as indicated on drawings.

2. Drawer sides and backs shall be 1/2" thick solid clear selected white birch, suitable for clear finish. Drawer bottom shall be 3/8" thick plywood with clear selected white birch veneers, suitable for clear finish.

3. Cabinet doors and drawers shall be flush mounted.

4. Adjustable shelves in cabinets shall have grommets spaced 2" o.c.

5. Fixed shelves shall be dadoed into side supports and glued.

6. Shelves shall be 3/4" thick for spans up to 30"; for spans in excess of 30" to 48" shelves shall be 1" thick.

7. All cabinets shall have closed top, sides, bottom, and back with veneers to match face work. Cabinets to fit accurately into indicated locations; scribe moldings permitted only where indicated.

8. Countertops, counters, counter fronts, shelves, etc., indicated on drawings to have plastic laminate, shall have plastic laminate shop applied to 3/4" thick core, with plastic laminate backing sheet on underside or back of countertops, counters and shelves. Plastic laminate shall be pressure laminated to core with laminate at external corners. Provide concealed wood framing to support plastic laminate counters, securely fastened to wall and to underside of counters.

C. Countertops shall be installed to support a minimum concentrated live load of 150 lbs. acting downward at mid span at outer edge of counter without causing deformation and damage.

3.12 WOOD BASES

A. Provide plywood backing, toggle bolted to substrate, if substrate not suitable for securing wood base.

B. Machine wood bases from specified wood, to profiles indicated on drawings.

C. Set base level and plumb. Where indicated on drawings, face of wood base shall be flush with wall above. Glue wood base to substrate or to plywood backing, and screw or nail wood base to substrate or to plywood backing with countersunk wood screws or with finishing nails, recess wood screw heads, and spackle with wood putty, set and spackle nails with wood putty. Do not nail or fasten wood base to floor. Ends of wood base shall be either splined or shiplapped.

D. Where no wood backing occurs, screw apply base at each stud with screw countersunk and wood putty applied and sanded smooth and flush with base.

3.13 WOOD DOOR FRAMES

A. Where indicated on drawings, provide wood frames and bucks for wood doors. Bucks shall be braced, set straight and plumb and have anchors for building into adjoining construction; space anchors not over two (2) feet apart (one foot from corners). Machine wood frames from specified solid wood to profiles indicated on drawings. Set frames plumb, level, square; securely attached to adjoining construction. Wood frames, bucks and trim shall conform to details.

3.14 PAINTING AND FINISHING

A. General: All painting and finishing work of this Section shall be shop applied, unless otherwise noted, as specified below. All painting and finishing shall match approved samples. Field finish painting, where specified below, shall be by painting Subcontractor, as specified for in Painting Section.

B. Back-Painting: All work of this Section in contact with concrete or masonry or other moisture areas and all concealed surfaces of cabinet and millwork, shall be back-painted with one (1) coat of oil-based paint prior to installation, shop applied where practicable.

C. Field Touch-Up: Field touch-up shall be the responsibility of the installing Subcontractor and shall include the filling and touch-up of exposed job made nail or screw holes, refinishing of raw surfaces resulting from job fitting, repair of job inflicted scratches and mars, and final cleaning up of the finished surfaces.

3.15 CLEAN UP AND PROTECTION

A. Clean Up: At regular intervals during the course of the work, all debris and excess material shall be cleaned up and removed from the site. Upon completion of installation, clean all spaces of debris caused by woodwork installation.

B. Protection: Protect all woodwork from marring, defacement of other damage until final completion and acceptance of the project by the Owner. Repair or replace all defective units prior to final inspection as directed by the Architect. Any units that cannot be satisfactorily repaired in the opinion of the Architect shall be replaced with new units of same original design, at no additional cost to the Owner.

END OF SECTION

DIVISION 07
THERMAL AND MOISTURE PROTECTION

SECTION 071113

BELOW-GRADE DAMPPROOFING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the below-grade dampproofing as shown on the drawings and/or specified herein, including but not limited to, the following:

1. Dampproofing applied to exterior side of foundation walls.

2. Protection board.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Earthwork - Section 312000.

1.4 SUBMITTALS

A. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.

B. Certification by dampproofing manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site, ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name, and manufacturer's name. Delivered materials shall be identical to approved samples.

B. Store materials under cover in a dry and clean location, off the ground. Remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.

1.6 JOB CONDITIONS

A. Environmental Requirements: Dampproofing materials shall not be installed on wet surfaces, or when the temperature is 32 deg. F. and falling.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide trowel grade mastic manufactured from a blend of selected asphalts, stabilizers, fibers and solvents in compliance with ASTM D 4586, Type 1, (non-asbestos) equal to Karnak 86 AF manufactured by the Karnak Corp. or equal made by Sonneborn, Anti-Hydro or approved equal.

B. Priming Material: Applied to the concrete surfaces prior to the installation of the dampproofing, as required and/or recommended by the manufacturer.

C. Protection Boards: For the protection of the dampproofing after installation and before backfilling: provide 1/8" thick, multi-ply, semi-rigid board, consisting of a mineral stabilized asphalt core sandwiched between layers of asphalt saturated felt, and faced on one side with polyethylene film.

1. W.R. Meadows Inc.

2. Sonneborn.

D. Glass Fabric: Woven glass fabric, treated with asphalt, complying with ASTM D 1668, Type I.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where below-grade dampproofing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Surfaces to Receive Dampproofing: Clean, dry, smooth and free from surface treatments which may inhibit the bond of the dampproofing. Treat imperfections in these surfaces such as large cracks, honeycombs and holes prior to the dampproofing application, by repair work consisting of filling with cement, or as directed.

B. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.

C. The start of the dampproofing installation shall imply acceptance of those surfaces, and conditions encountered in the field, to install the work, as recommended and as specified.

3.3 INSTALLATION

A. Perform the work using skilled workmen in accordance with the acceptable manufacturer's instructions and directions.

B. Prime surfaces to receive dampproofing using Karnak No. 108 primer, as recommended by the manufacturer, carefully following label instructions as to rate of coverage.

C. Apply two (2) coats of dampproofing continuously, at a rate of 6 gallon/100 sq. ft. per coat.

D. At changes in plane or where otherwise shown as "reinforced", install lapped course of glass fabric in first coat of dampproofing compound before it thickens.

E. Install 2" x 2" cant strip of bituminous grout at base of vertical dampproofing where it meets horizontal surface.

F. Apply vertical dampproofing down walls from finished grade line to top of footing, extend over top of footing, and down a minimum of 6" over outside face of footing. Extend 12" onto intersecting walls and footings, but do not extend onto surfaces exposed to view when the Project is completed.

G. Protect the installed dampproofing by embedding the protection boards into the dampproofing when the dampproofing becomes tacky, or as recommended by the manufacturer.

3.4 PROTECTION

A. Protect surfaces adjacent to the dampproofing operations against staining or other damage during the work of this Section.

B. Staining or soiling which does occur to the adjacent materials shall be removed as the work progresses, including smear, spills or displaced materials. Leave installed work in a neat condition upon completion.

C. Backfilling against completed dampproofing shall not occur for at least 72 hours.

END OF SECTION

SECTION 071326

SHEET MEMBRANE WATERPROOFING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the sheet membrane waterproofing as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Sheet membrane waterproofing for underslab conditions.

2. Sheet membrane waterproofing for foundation wall surfaces.

3. Sheet membrane waterproofing for blindside of foundation wall surfaces.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Earthwork - Section 312000.

1.4 QUALITY ASSURANCE

A. Preinstallation Conference: Approximately 2 weeks prior to scheduled commencement of waterproofing installation, meet at Project site with Waterproofing Installer; preparer of substrate to receive waterproofing; installers of other work in and around waterproofing that must precede, follow, or penetrate waterproofing (including Mechanical and Electrical Installers as applicable); Architect; Owner; and waterproofing manufacturer's representative to review materials, procedures, schedules, and other requirements and conditions related to installing waterproofing.

B. Qualifications of Subcontractors

1. Subcontractors: All work of this Section shall be performed by a subcontractor who is approved by the manufacturer of the waterproofing material.

2. Qualifications of Subcontractors: Subcontractors shall submit evidence of being bona fide waterproofing subcontractors, for a period of not less than five (5) years, and that they are approved by the manufacturer of the waterproofing material for the installation of the manufacturer’s material in accordance with the requirements of this Section.

a. Subcontractor shall submit a letter from manufacturer of waterproofing material stating that subcontractor is approved by the manufacturer for the application of the waterproofing systems specified and accepted for use on the Project.
b. Letter shall certify that the subcontractor has previously and satisfactorily applied the waterproofing systems specified herein on jobs of similar size and scope, under manufacturer’s supervision.

c. Letter shall be on manufacturer's letterhead and shall be signed by an officer of the company, not by a local sales representative.

C. Manufacturer's Representative/Contractor's Certification

1. Representative of the waterproofing material manufacturer shall be required to provide field instructions and supervision for the installation of the waterproofing systems at the start of the work of this Section.

2. The manufacturer's representative shall be required to make sure that the workmen for waterproofing systems on the site of the Project are fully instructed and trained in the handling and application of all the materials and shall see that all the materials are correctly installed.

3. Upon completion of the Installation, submit to the Architect written certification that the representative of the manufacturer of the waterproofing material has supervised the work of this Section and that all materials were correctly installed.

D. The project Geotechnical Report shall be provided to the Manufacturer for review and approval at time of waterproofing applicator's bid.

E. A preinstallation meeting shall be coordinated by the General Contractor and attended by an Owner's Representative, the Waterproofing Consultant, the waterproofing applicator and membrane manufacturer's representative. Any trade having relevant or adjacent work to blindside system before, during and after installation should also be present and properly represented by a Project Manager and Job Foreman. These trades include the Foundation Contractor, the Concrete Contractor, the Steel Reinforcement Contractor, the Mechanical Contractor, the Electrical Contractor and the Plumbing Contractor. The purpose of this meeting is to discuss the necessity of ensuring proper waterproofing membrane protection during all phases of installation and to review other applicable requirements or unusual field conditions.

F. Upon request by the Approved Applicator, an inspection will be conducted by the Manufacturer's representative to ensure that the waterproofing membrane has been installed according to the Manufacture's specifications and details. This inspection shall be coordinated prior to installing the blindside components so that access to the membrane is not impaired.

G. An in-progress inspection may be scheduled after the initial inspection (after the membrane installation is completed) to ensure proper protection procedures are being followed to prevent possible damage to the membrane during the installation of above membrane components.

H. Manufacturer shall have access to the job site at the start of installation, periodically as work progresses and after installation completion for the waterproofing and any other relevant or adjacent work.

1.5 SUBMITTALS

A. Shop Drawings: Typical installation details, showing details at flashings, at terminations, at joints, at intersection of horizontal and vertical surfaces, and at penetrations in membrane system.

B. Samples - Submit

1. Membrane, 6" x 6" samples of each membrane.

2. 6" x 6" sample of flashing.

3. 6" x 6" sample of drainage board.

C. Manufacturer's Literature: Submit manufacturer's technical, safety data sheets, and installation literature for all materials of this Section. Submit Independent Test data indicating that membrane meets properties specified herein.

D. General Contractor's Certification: Submit per Article 1.4.

1.6 STORAGE OF MATERIALS

A. All materials shall be stored in their original tightly sealed containers or unopened packages; shall be clearly labeled with the manufacturer's name, brand name and number, and batch number of the material with expiration date where appropriate.

B. Materials shall be stored in a neat and safe manner so as not to exceed the allowable live load of the storage area.

C. Material shall be stored out of the weather in a clean, dry area.

D. Liquid materials, such as adhesives, thinners and primers, shall be stored in areas away from sparks, open flames and excessive heat.

1.7 JOB CONDITIONS

A. No application of waterproofing shall commence or proceed during inclement weather, or the threat of imminent precipitation.

B. All surfaces to receive the system shall be thoroughly dry and free of dew or frost.

C. Materials shall be stored until time of mixing at temperatures above 60 deg. F. to maintain a consistency suitable for mixing. Do no work below 40 deg. F.

D. Prior to and during application, all dirt and dust shall be removed from surfaces either by vacuuming, sweeping, blowing with compressed air, or similar methods.

E. Surfaces not designated to receive the system shall be properly masked or otherwise protected against accidental spillage or application of the material to those areas.

1.8 PROTECTION

A. Against Loads: Protect work of this Section against concentrated loads and any other loads or equipment that would damage the materials or work.

B. Against Traffic: Do not permit traffic on horizontally installed work of this Section, except for workmen doing the work, during the installation, and after the installation until membrane systems are covered with protective boards or with the specified finishing materials.

C. Against Damage: Protect vertically installed work of this section from damage by reinforcing and placement.

1. Take and maintain necessary preventive measures to protect work of this Section from damage until Project is accepted.

2. Rejection of Damaged Work

a. Damaged materials or work will be rejected.
b. Rejected materials or work must be immediately removed and replaced with new materials.

1.9 FIELD QUALITY CONTROL

A. Construction Traffic:

1. Limit construction traffic over completed membrane.

2. General Contractor shall provide 1/2" plywood protection layer, where construction traffic is unavoidable.

B. Inform Architect in writing on a daily basis of any of the following events. State specific location of each occurrence.

1. Buckling to the Waterproofing and other deformations as a result of ground water events.

2. Leakage through the finished waterproofing installation.

3. Damage by other trades.

C. Provide Manufacturer's Representative's report (prior to backfill) stating that the waterproofing has been inspected and is acceptable and eligible for manufacturer's warranty.

1.10 WARRANTY

A. The manufacturer of the waterproofing system executed under this Section warrants the waterproofing system to be watertight and free from defects in materials and workmanship for a period of ten (10) years from date of acceptance of this Contract, and that he, agrees to promptly make repairs or replace defective waterproofing materials during the warranty period.

B. Contractor's Two-Year Workmanship Warranty: Provide a written guarantee for all work of this Section, stating that if, within two years after the Date of Substantial Completion of the Work, any of the work is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly after receipt of a written notice from the Owner to do so. The guarantee shall state that the Contractor shall bear all costs incurred by the Owner, including reasonable attorney's fees, to enforce compliance with the obligations of this Guarantee, and will replace any material or system that requires repeated maintenance or repair to function effectively. The obligation of this Guarantee shall run directly to the Owner and may be enforced by the Owner against the Contractor, shall survive the termination of the Contract and shall not be limited by Conditions other than this Contract.

PART 2 PRODUCTS

2.1 WATERPROOFING MEMBRANE

A. Trade names used herein for membrane waterproofing are those of GCP Applied Technologies. Provide specified products or approved equal acceptable to the Architect.

B. For accessible foundation walls, provide "Bituthene 4000" sheet waterproofing membrane, 60 mils thick and "Liquid Membrane," 60 mils thick, for flashing, as manufactured by GCP Applied Technologies or approved equal.

C. At under-slab conditions, provide adhesive coated HDPE Composite Sheet "Preprufe 300R Plus" system by GCP Applied Technologies or approved equal.

1. Blindside HDPE membrane or reinforced TPO membrane shall have a protective layer to protect the membrane from the weather and U.V. for up to 56 days before casting concrete against it.

D. At vertical blind side waterproof conditions, provide adhesive-coated HDPE composite sheet "Preprufe 160R Plus" system by GCP Applied Technologies or approved equal.

E. Primer/Conditioner: "Bituthene 4000" latex/water-based primer specifically formulated to provide adhesion of Bituthene Waterproofing Membranes.

1. If water-based primer does not provide sufficient adhesion to substrate, substitute Bituthane Primer B-2 solvent-based primer.

F. Mastic: "Bituthene Elastomeric Mastic" rubberized asphalt-based mastic.

G. Tape: Double sided synthetic adhesive tape equal to "Preprufe LT" and "HC."

H. Protection Board: 1/4" thick semi-rigid protection board, "Bituthene Asphaltic Hardboard."

I. Bituthene Liquid Membrane: Two-component 100% solids trowel grade asphalt modified urethane.

J. Drainage Board/Composite

1. For vertical application, use "Hydroduct 220" prefabricated dimpled polystyrene drainage core with a non-woven filter fabric on one side and a polymer film on the reverse side, by GCP Applied Technologies.

2. At horizontal applications, use "Hydroduct 660" by GCP Applied Technologies.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where membrane waterproofing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work. Starting of work implies acceptance of substrate.

3.2 PREPARATION OF SURFACES TO RECEIVE WATERPROOFING

A. Conform to the requirements of specified manufacturer.

B. Earth or crushed stone substrates shall be compacted to produce an even, sound substrate. Loose aggregate, sharp protrusions and standing water shall be removed.

3.3 INSTALLATION OF FOUNDATION WALL WATERPROOFING

A. General: Conform to recommendations and published specifications of the manufacturer' including environmental requirements and preparation requirements to receive waterproofing.

B. Accessible Foundation Walls

1. General: The membrane, when in place must withstand a minimum static ground water pressure of 150 feet.

2. Priming: Application of primer shall be limited to what can be covered with Bituthene Waterproofing Membrane in a given work day. Primed areas not covered by membrane during the work day will be reprimed. Apply primer by spray, roller or brush at a rate of 250 - 350 sq. ft. per gallon. Roller shall be natural material such as lamb's wool, having a nap of approximately one inch. Primer shall be applied to a clean, dry, frost-free and dust-free surface. Sufficient primer must be used on the day

surface to condition it to a dust-free state suitable for the application of Bituthene Waterproofing Membranes.

a. Bituthene 4000 Surface Conditioner should not be applied below 25 deg. F. on vertical surfaces. Allow primer to dry 30 minutes. Conditioner is considered dry when the substrate returns to its original color.
b. Re-prime areas that become dusty or dirty prior to membrane installation.

3. Membrane Installation: Apply Bituthene Waterproofing Membrane vertically in sections of 8' in length or less. On higher walls apply two or more sections with the upper overlapping the lower by a least 2-1/2". Press all membrane in place with heavy hand pressure or rollers during application.

4. Sealing Edges: Bituthene Waterproofing Membrane shall be applied over the edge of the slab or over the top of the foundation or parapet wall. If the membranes are terminated on the vertical surface, a reglet or counter flashing may be used or the membrane may be terminated directly on the vertical surface by pressing very firmly to the wall. Press edges with a metal or hardwood tool such as a hammer or knife handle. Apply a troweled bead of Bituthene Mastic to all vertical and horizontal terminations. Bituthene Liquid Membrane can be used as an alternative method at the General Contractor's option.

5. Sealing Seams: All edges and end seams must be overlapped at least 2-1/2". Apply succeeding sheets with a minimum 2-1/2" overlap and stagger end laps. Roll or press the entire membrane firmly and completely as soon as possible. Patch misaligned or inadequately lapped seams with Bituthene Membrane. Slit any fish mouths, overlap the flaps, and repair with a patch of Bituthene and press or roll in place. The edges of the patch shall be sealed with a troweling of mastic. Laps within 12" of all corners shall be sealed with a troweling of mastic.

6. Corner Forming: Outside corners must be free of sharp edges. Inside corners shall receive a fillet formed with Liquid Membrane, latex modified cement mortar equal to Daraweld C made by Grace mixed with cement mortar or epoxy mortar. Do not use fiber or wood cants. One of two methods may be used for treating corners at the General Contractor's option:

a. Apply Bituthene Liquid Membrane 6" in each direction from the corner and form a fillet with a minimum 3/4" face.
b. Install an 11" minimum strip of Bituthene Membrane centered on the corner. Install Bituthene Membrane over the treated inside and outside corners.

7. Over waterproofing, apply drainage composite board by adhering board to cured membrane using tape or adhesive per manufacturer’s recommendations; lap all edges 4” and conform to the following:

a. Install drainage layer directly over the membrane. Start at the low points on the wall and shingle all laps to the flow of water.
b. Splice drainage panels together by butting longitudinal edges of adjacent sheets and peeling back fabric to expose the cores of the panels. Install precut “lock strips” consisting of 4 dimple x 5 dimple sections of the drainage panel centered on the joint between the panels and spaced every 10 dimples along the length of the joint. Snap dimples of "lock strip" to dimples of each panel and reattach fabric over the panel joint.
c. Cut the core of the drainage panels around penetrations and cut an 'X' in the filter fabric and tape the fabric to the sides of the penetration.
d. Cover all terminal edges of the drainage composite with an integral fabric flap by tucking the fabric around the edge of the core and adhering the fabric to the bottom of the core.

3.4 INSTALLATION OF BELOW-GRADE, UNDERSLAB WATERPROOFING

A. General: Install adhesive coated HDPE composite sheet according to waterproofing manufacturer's written instructions.

B. Preparation

1. Surfaces to receive blind side membranes must be smooth and sound, with no gaps or voids in excess of 1/2 in. Earth and stone substrates must be compacted to produce an even, solid substrate. If required by membrane manufacturer, provide an additional layer of underlayment protection board over sharp or angular stone substrates. Surfaces to receive waterproofing shall be thoroughly dry and free of moisture.

2. General: Comply with manufacturer's instructions for preparing surface including joint or crack treatment.

3. Apply primer to substrate surfaces at rate recommended by manufacturer of primary waterproofing materials. Prime only area that will be covered by waterproofing membrane in same working day. Reprime areas not covered by waterproofing membrane within 24 hrs.

C. Underslab Applications

1. Apply Hydroduct 660 drainage composite board as recommended by manufacturer over the compacted sub-grade.

2. Apply the membrane over the drainage composite board with the HDPE side facing the drainage composite board and the treated white coating surface facing the concrete to be poured. The membrane may be installed at any convenient length. Apply succeeding sheets by overlapping previous sheets 3" along the self-adhesive edge of the membrane. Remove the silicone coated release liner covering the membrane and roll the side lap to assure a tight seal.

3.5 INSTALLATION OF VERTICAL BLIND-SIDE WATERPROOFING

A. General: Install adhesive coated HDPE composite sheet according to waterproofing manufacturer's written instructions.

1. Install drainage layer directly over the membrane. Start at the low points on the wall and shingle all laps to the flow of water.

2. Splice drainage panels together by butting longitudinal edges of adjacent sheets and peeling back fabric to expose the cores of the panels. Install precut “lock strips” consisting of 4 dimple x 5 dimple sections of the drainage panel centered on the joint between the panels and spaced every 10 dimples along the length of the joint. Snap dimples of “lock strip” to dimples of each panel and reattach fabric over the panel joint.

3. Cut the core of the drainage panels around penetrations and cut an 'X' in the filter fabric and tape the fabric to the sides of the penetration.

4. Cover all terminal edges of the drainage composite with an integral fabric flap by tucking the fabric around the edge of the core and adhering the fabric to the bottom of the core.

B. Preparation

1. Surfaces to receive blind side membranes must be smooth and sound, with no gaps or voids in excess of 1/2". Earth and stone substrates must be compacted to produce an even, solid substrate. If required by membrane manufacturer, provide an additional layer of underlayment protection board

over sharp or angular stone substrates. Surfaces to receive waterproofing shall be thoroughly dry and free of moisture.

2. General: Comply with manufacturer's instructions for preparing surface including joint or crack treatment.

3. Apply primer to substrate surfaces at rate recommended by manufacturer of primary waterproofing materials. Prime only area that will be covered by waterproofing membrane in same working day. Reprime areas not covered by waterproofing membrane within 24 hours.

C. Wall Applications: Refer to manufacturer's literature for complete installation instructions but not limited to the following:

1. Apply Hydroduct 220 Drainage Composite to a point 6" below grade line. Fasten Hydroduct 220 to the adjacent buildings foundation wall or soil retention system.

2. Peel back bottom flap of filter fabric and place core behind discharge pipe. Wrap loose filter fabric over and around discharge pipe. Tuck excess filter fabric behind pipe. Fold excess filter fabric at top termination down between drainage composite and membrane.

3. Apply membrane with the HDPE film facing the soil retention system or adjacent foundation. Remove the release liner and fasten membrane to Hydroduct drainage composite with large head nails or staples. All nail heads or staples must be covered with overlapping sheets of membrane.

4. Apply succeeding sheets by overlapping the previous sheet 3 inches along the uncoated edge of the membrane.

5. Overlap the ends of the membrane 3 inches. Apply Preprufe Tape centered over the end lap and roll firmly. Remove release liner.

6. Seal all transition, penetrations, tie down bracing and other conditions with initial membrane layer plus manufacturer's recommended accessory materials, prior to application of the full membrane.

7. Concrete must be poured within 30 days of membrane application. Protect membrane until concrete pour.

8. If membrane ties into a vertical membrane, leave an additional 12" flap of Preprufe membrane to tie into Bituthene membrane.

3.6 SEAM REINFORCEMENT FOR HDPE COMPOSITE SHEETS ONLY

A. Provide a 6" strip of modified bituminous sheet membrane (Bituthene 4000) centered behind all laps.

B. At locations where a salvage edge is not present and at end laps, lap sheets 6", apply a 1/8" thick by 6" wide application of liquid membrane between sheets, to provide a 6" wide seal.

C. Integration of old onto new pre-applied sheet membrane.

1. Integration of Sheet Membrane onto Sheet Membrane that has been installed in excess of 30 days prior

a. Lap sheets 12", apply a 1/8" thick by 12" wide application of fluid membrane between sheets, to provide a 12" wide seal at this location.
b. Install Waterproofing Tape centered at edge of lap and roll firmly into place with an approved roller.
c. Install additional Waterproofing Tape to cover white film that has been installed over 30 days prior.

2. Repair of pre-applied sheet membrane

    a. Scratch on white coating exposing underlying black surface of Sheet Membrane. Install Waterproofing Tape at areas where the white coating of the membrane is damaged, including boot scuff marks and abrasions by rebar.
    b. Damage or Puncture of Sheet Membrane: Install Patch of short Membrane set in Liquid Membrane. Patch must extend 3" in every direction around extent of damaged area. Install Waterproofing Tape centered over the edge of the patch. If the damaged area does not have 5" of sound material around it, inject Liquid Membrane into puncture until Liquid Membrane backs out, and proceed with patch as space allows.

3.7 CLEAN-UP

A. Upon completion of the waterproofing system, the General Contractor shall remove all equipment, material and debris from the work and storage area, and leave those areas in an undamaged and acceptable condition.

END OF SECTION

SECTION 071616

CRYSTALLINE WATERPROOFING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the crystalline waterproofing as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Crystalline waterproofing system for inside surface of foundation walls and interior surfaces of concrete pits and trenches, including elevator pits.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.4 SUBMITTALS

A. Shop Drawings: Submit shop drawings showing details at terminations, at joints, at intersection of horizontal and vertical surfaces, and at penetrations in waterproofing system.

B. Product Data: Submit manufacturer's technical information and installation instructions for all materials of this Section.

C. Contractor's Certification: Submit per Article 1.6.

D. Subcontractor's Qualifications: Submit per Article 1.7.

1.5 STORAGE OF MATERIALS

A. All materials shall be stored in their original tightly sealed containers or unopened packages; shall be clearly labeled with the manufacturer's name, brand name and number, and batch number of the material where appropriate.

B. Materials shall be stored in a neat and safe manner so as not to exceed the allowable live load of the storage area.

C. Material shall be stored out of the weather in a clean, dry area.

1.6 MANUFACTURER'S REPRESENTATIVE

A. Contractor shall require representative of manufacturer of the waterproofing material to provide field instructions and supervision of the installation of the complete waterproofing system.

B. Contractor shall require the manufacturer's representative to make sure that the subcontractor's workmen are fully instructed and trained in the handling and application of all the materials, and shall see that all the materials are correctly installed.

C. Upon completion of the installation, the Contractor shall submit to the Architect a written certification that the representative of the manufacturer of the waterproofing material has supervised the work of this Section and that all materials are correctly installed.

1.7 QUALIFICATIONS OF SUBCONTRACTORS

A. Subcontractors: All work of this Section shall be performed by a subcontractor who is approved by the manufacturer of the waterproofing material.

B. Qualifications of Subcontractors: Subcontractors, in order to obtain Architect's acceptance for doing work of this Section, shall submit evidence of being bona fide waterproofing subcontractors, and that they are approved by the manufacturers of the waterproofing material for the installation of their material in accordance with the requirements of this Section. Subcontractor shall submit letter from manufacturer of waterproofing material stating that the subcontractor is approved by the manufacturer for the application of the waterproofing system specified for the Project. Letter shall certify that the subcontractor has satisfactorily applied the waterproofing system specified herein under manufacturer's supervision. Letter shall be on manufacturer's letterhead and shall be signed by an officer of the company.

1.8 WARRANTY

A. The Contractor and manufacturer shall jointly warrant the waterproofing system executed under this Section to be watertight and free from defects in materials and workmanship for a period of ten (10) years from date of acceptance of this Contract, and that he, at his own expense, repair and/or replace all other work which may be damaged as a result of such defective work, and which becomes defective during the warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

A. Waterproofing materials shall be a cement bond compound, free from chloride and iron oxide, which waterproofs by crystalline growth through the capillary tracts and shrinkage cracks in the concrete substrate equal to "Aqua-Fin IC," as manufactured by Aqua-Fin Inc., or comparable product by Xypex Chemical Corp., Anti-Hydro Co., or approved equal.

B. Mixing Water: Potable.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where crystalline waterproofing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Temperature Requirements: Surrounding temperatures shall be a minimum thirty-five (35) degrees F. for forty-eight (48) hours before, during and after installation.

B. Preparation of Surfaces

1. Surfaces to be waterproofed shall be clean and free of form scale, mold, laitance, oil, form release agents, curing compounds, hardeners, and any other materials likely to affect the bond penetration or performance of the waterproofing materials.

2. Materials shall not be applied to frozen or frosted surfaces, nor during rain or snow.

3. The presence of moisture in the concrete substrates is essential at the time of the waterproofing application. Should this not be the case, soak thoroughly all surfaces with water a day prior to the waterproofing, and remove all free laying water.

4. All cracks in the concrete structure exceeding 0.01" in width and construction joints which have not been treated before with crystalline waterproofing, shall be routed out to a minimum depth of 3/4".

5. Areas that have become dirty and concrete pours which have resulted in an extremely smooth surface shall be acid etched or, at the Contractor's option, may be sand blasted. Surfaces to be acid etched shall be dampened with clean water. Etching shall be done with a fifteen (15) percent hydrochloric (muriatic) acid. One gallon of acid should cover about fifty (50) to seventy-nine (79) square feet. Allow the acid to stand at least three (3) minutes and when bubbling ceases, flush off with water immediately. Do not let the acid stay on the surface for a prolonged period. When completed, the surface shall have a finish similar to fine or medium sandpaper. Surfaces which retain a smoothness or dirty condition shall be re-etched until the desired effect is obtained.

6. Fill Form: Tie holes with "Aqua-Fin Mortar" of mortar consistency.

7. Vertical Concrete Surfaces

    a. Grind off all fins and other projections.
    b. Extremely smooth surfaces must be etched or sand blasted.
    c. Form ties with insets shall be removed. Chip back concrete approximately one (1) inch where form ties are without insets.
    d. Honeycombed Pockets and Faulty Construction Joints: Rout out all faulty materials back to sound concrete; clean and rinse thoroughly with water all surfaces to be treated; check by rubbing hand over the surfaces. Hand should not become wet.

C. Mixing of Crystalline Waterproofing Materials

1. Slurry Consistency: The crystalline waterproofing materials shall be delivered in powder consistency in original undamaged containers with manufacturer's labels and seals intact.

    a. Separate container shall be used for measuring by volume the powdery crystalline waterproofing and the water.
    b. Measure two (2) parts of crystalline waterproofing and 0.7 - 0.9 parts of water (depending on water or absorption of concrete).

2. Mortar Consistency for Seal Strips and Coves

    a. Add water to crystalline waterproofing and/or crystalline waterproofing reinforcing proportion 1:2 and/or 1:3 and mix thoroughly until stiff consistency is reached.
    b. Prepare only as much mortar as can be applied within ten (10) minutes.

D. Installation of Crystalline Waterproofing Materials

1. Slurry Application

    a. Concrete surfaces to be treated with crystalline waterproofing shall be moist, not wet.
    b. Crystalline waterproofing slurry coatings shall be applied with a stiff masonry brush or stiff broom and worked into every irregularity of the concrete surfaces.
    c. Prior to the specified final application of crystalline waterproofing slurry coatings on the concrete surface, the following initial applications and repairs to the concrete structure have to be completed.

2. Construction Joints

   a. Construction joints shall receive a slurry coating of crystalline waterproofing 2.5 lbs. per square yard immediately prior to each concrete pour. In areas where inaccessibility is difficult, apply 2.5 lbs. per square yard of crystalline waterproofing by dry sprinkle method immediately prior to the following pour or rout out to a minimum depth of 3/4".
   b. Apply slurry coating of crystalline waterproofing 1.5 lbs. per square yard to routed out areas of cracks and construction joints and fill remaining depth with crystalline waterproofing and crystalline waterproofing reinforcing 1:6 in mortar consistency in two (2) laminating layers after each layer has reached its initial set (approximately 20-30 minutes).

3. Installation of Crystalline Waterproofing Coves (Junction Horizontal Surfaces and Walls): Apply slurry coating of crystalline waterproofing 1.5 - 2.0 lbs. per square yard, six (6) inches in width, and install a cove with crystalline waterproofing and crystalline waterproofing reinforcing 1:3 in mortar consistency.

4. Honeycombed Pockets in Wall Areas: Rout out all faulty materials back to sound concrete. Apply slurry coating of crystalline waterproofing 1.5 lbs. per square yard over routed out area and fill with sand and cement mortar 1:3. If necessary (owing to depth) apply layers of mortar not exceeding 5/8" in thickness after each layer has hardened and repeat crystalline waterproofing slurry coating.

5. Foundation and Pit Walls - Interior Face

   a. Moisture treat vertical concrete surfaces thoroughly one day prior to application. Construction joints and form tie holes shall be filled with crystalline waterproofing and crystalline waterproofing reinforcing 1:6 in mortar consistency.
   b. Apply two (2) slurry coatings on entire surface, consisting of "Aqua-Fin IC" crystalline waterproofing 1.25 lbs. per square yard per coating, to levels and on surfaces indicated. The second coating shall be applied while the first coating is green, normally within an hour or the application of first coating.

6. Concrete Slabs – Pits: Apply Aqua-Fin IC at the rate of 2.5 lbs./sq. yd. in slurry consistency to concrete slab surfaces in one coat.

E. Curing of Crystalline Waterproofing Application

1. Crystalline waterproofing applications while setting shall be protected from rain, frost and from drying out. During extreme hot weather, light water fog spraying may be necessary during time of application.

2. Moisture treat crystalline waterproofing treated areas for minimum period of three (3) days starting the day following the completion of the crystalline waterproofing application with fog water spray. Surfaces shall have moist and later wet appearance for the duration of the curing period.

3. Treated surfaces shall not be exposed to aggressive water, chemicals or acids until the applications have reached full strength (normally after 14 days).

F. Crystalline Waterproofing with Painted Finish: All crystalline waterproofing surfaces to receive paint shall be neutralized with a solution of muriatic acid and water 1:8 (or vinegar salt water solution) after the crystalline waterproofing application has aged for a minimum period of two (2) weeks.

1. Rinse thoroughly with water all treated surfaces.

END OF SECTION

SECTION 072100

THERMAL INSULATION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the thermal insulation as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Foundation wall insulation.
2. Cavity-wall insulation.
3. Blanket insulation.
4. Vapor permeance vapor retarder.
5. Spray-foam insulation at gaps around glazing frames, door frames, penetrations, and similar items in exterior wall assemblies for tie-in of air/vapor barrier to frames.
6. Semi-rigid mineral wool at mechanical room ceiling.
7. Attachment devices.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Roof insulation - Division 7.

C. Firestops and Smokeseals - Section 078413.

D. Gypsum Drywall - Section 092900, for acoustical insulation.

E. Earthwork - Division 31.

1.4 SUBMITTALS

A. Submit product data for each type of product indicated, including re-cycled content.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulation products.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Vertical and Lateral Fire Propagation Test Characteristics: The exterior wall assembly is required to comply with NFPA 285 "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components." The base wall, stud cavity insulation, wall sheathing, air barrier, continuous wall rigid insulation and exterior cladding are components that are required to be to be evaluated as part of this specific assembly test. The basis of design product listed herein is a component of the design test assembly selected by the Architect.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Deliver materials to the site ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type and brand. Delivered materials shall be identical to approved samples.

C. Store materials under cover in a dry and clean location, off the ground. Remove materials which are damaged or otherwise not suitable for installation and replace with acceptable materials.

D. Take every precaution to prevent the insulation from becoming wet, cover with tarps or other weather/watertight sheet goods.

PART 2 PRODUCTS

2.1 FOUNDATION WALL INSULATION

A. Provide extruded polystyrene board insulation equal to "Styrofoam" manufactured by Dow Chemical Co., or approved equal made by Owens Corning or PACTIV Building Products, conforming to ASTM C 578, Type IV, with a maximum flame spread and smoke developed indices of 75 and 450 respectively.

B. Insulation shall have an aged R value of not less than 5/inch; shall be 2" thick unless otherwise noted on the drawings.

2.2 CAVITY WALL INSULATION

A. Provide "RainBarrier HD" by Thermafiber, "CavityRock DD" by Rockwool or approved equal conforming to ASTM C 612, with maximum flame-spread and smoke-developed indexes of 15 and 0, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Insulation shall comply with NFPA 285.

1. Thickness: 4", unless otherwise indicated.

2. Nominal density of 6 lb./cu. ft., thermal resistivity of 4.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.3 BLANKET INSULATION

A. Provide flexible mineral fiber blankets/batts equal to "ComfortBatt" as manufactured by Rockwool or equal made by Owens Corning, Johns Manville or CertainTeed conforming to ASTM C 665, Type 1, Class A, with maximum flame spread and smoke developed indices of 0.

1. Insulation shall have an R value of not less than 3.7/inch and shall be 3.5" thick unless otherwise noted on the drawings.

2.4 VARIABLE PERMEANCE VAPOR RETARDER

A. Provide CertainTeed "MemBrain, The SMART Vapor Retarder," polyimide film vapor retarder for use unfaced fiberglass insulation. Material has a permeance of 1 perm or less when tested to ASTM E 86, dry cup method and increases to greater than 10 perms using the wet cup method.

B. Surface Burning Characteristics per ASTM E 84:

1. Maximum Flame Spread Index: 20.

2. Maximum Smoke Developed Index: 55.

2.5 MINERAL WOOL AT MEP CEILING

A. Unfaced, Mineral-Wool Board Insulation: ASTM C 612; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Nominal density of 8 lb/cu. ft., Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F.

2. Fiber Color: Darkened, where indicated.

2.6 SPRAY FOAM INSULATION

A. Spray Insulation at Perimeter of Frames and Penetrations: Provide closed-cell polyurethane foam insulation product to fill gaps, joints, etc. that both seals and insulates, equal to "Great Stuff Professional Foam" as manufactured by the Dow Chemical Co., or approved equal.

2.7 ACCESSORIES

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place. Provide "Series T TACTOO Insul-Hangers" by AGM Industries, Inc., "Spindle Type" by Gemco, or approved equal.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030" thick by 2" square.

2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105" in diameter; length to suit depth of insulation indicated.

3. Affix plate with stainless steel staple or screw.

B. Insulation Fastening System at CMU and Concrete: Provide "Ramset Insulfast" system, or approved equal, mechanical fastening system.

C. Adhesive for Bonding Insulation: The type recommended by the insulation manufacturer, and complying with fire-resistance requirements.

1. For bonding rigid polystyrene insulation to masonry or concrete, provide adhesive equal to "Foamgrab PS" made by Dacor Products Co. or equal made by ChemRex Inc. or Miracle Adhesives.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where thermal insulation is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION, GENERAL

A. Clean substrates of substances that are harmful to insulation including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

B. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

C. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

D. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

A. Set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions. If not otherwise indicated, extend insulation a minimum of 24" below exterior grade line.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

A. Install pads of adhesive spaced approximately 24" o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.5 INSTALLATION OF BLANKET INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

4. For metal-framed wall cavities where cavity heights exceed 96", support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Install membrane over all unfaced blanket insulation at perimeter wall, following manufacturers installation guidelines.

3.6 INSTALLATION OF SPRAY FOAM INSULATION

A. Apply self-supported, spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make it flush with face of studs by using method recommended by insulation manufacturer.

3.7 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 072700

VAPOR PERMEABLE AIR BARRIER LIQUID MEMBRANE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the fluid-applied membrane air barrier as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Fluid-applied vapor permeable air barrier applied over gypsum sheathing and cold-formed metal framing and concrete unit masonry.

2. Materials and installation to bridge and seal the following air leakage pathways and gaps:

a. Connections of the walls to the roof.
b. Connections of the walls to the foundations.
c. Seismic and expansion joints.
d. Openings and penetrations of window frames, storefront, curtain wall.
e. Door frames.
f. Piping, conduit, duct and similar penetrations.
g. Masonry ties, screws, bolts and similar penetrations.
h. All other air leakage pathways in the building envelope.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Thermal Insulation - Section 072100.

1.4 PERFORMANCE REQUIREMENTS

A. Provide air/vapor barrier constructed to perform as a continuous air/vapor barrier, and as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. Membrane shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air seal materials at such locations, changes in substrate and perimeter conditions.

B. Provide an air barrier assembly that has been tested in accordance with the Air Barrier Association of America's (ABAA's) approved testing protocol to provide air leakage results not to exceed 0.01 cfm/sf @ 1.57 psf.

C. Connections to Adjacent Materials: Provide connections to adjacent materials at the following locations and show same on shop drawings:

1. Foundation and walls, including penetrations, ties and anchors.
2. Walls, windows, curtain walls, storefronts, louvers or doors.
3. Different wall assemblies, and fixed openings within those assemblies.
4. Wall and roof connections.
5. Floors over unconditioned space.
6. Walls, floor and roof across construction, control and expansion joints.
7. Walls, floors and roof to utility, pipe and duct penetrations.
8. Seismic and expansion joints.
9. All other leakage pathways in the building envelope.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. The air barrier contractor shall be, during the bidding period as well as for the duration of the installation, officially recognized as a Licensed Contractor by the Air Barrier Association of America (ABAA). The contractor shall carry liability insurance and bonding.
2. Each worker who is installing air barriers must be either a Certified Applicator or an installer who is registered with ABAA.
3. Each Lead Certified Applicator can supervise a maximum of five registered installers. The Certified Applicator shall be thoroughly trained and experienced in the installation of air barriers of the types being applied. Lead Certified Applicators shall perform or directly supervise all air/vapor barrier work on the project.

B. Single-Source Responsibility: Obtain air/vapor barrier materials from a single manufacturer regularly engaged in manufacturing the product.

C. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

D. Field-Constructed Mock-Ups: Prior to installation of air/vapor barrier, apply air/vapor barrier as follows to verify details under shop drawing submittals and to demonstrate tie-ins with adjoining construction, and other termination conditions, as well as qualities of materials and execution:

1. Subject to compliance with requirements, approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Test mock-up in accordance with ASTM E 783 and ASTM E1105 for air and water infiltration.

F. Manufacturer shall be on-site at least once a week to observe installation and provide written report within 3 days.

G. Manufacturer shall confirm all termination details and compatibility with materials being terminated to.

H. Vertical and Lateral Fire Propagation Test Characteristics: The exterior wall assembly is required to comply with NFPA 285 "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components." The base wall, stud cavity insulation, wall sheathing, air barrier, continuous wall rigid insulation and exterior cladding are components that are required to be to be evaluated as part of this specific assembly test. The basis of design product listed herein is a component of the design test assembly selected by the Architect.

1.6 SUBMITTALS

A. Provide evidence to the Architect of licensing and certification under the Air Barrier Association of America's (ABAA's) Quality Assurance Program.

B. Submit shop drawings showing locations and extent of air/vapor barrier and details of all typical conditions, intersections with other envelope systems and materials, membrane counter-flashings, and details showing how gaps in the construction will be bridged, how inside and outside corners are negotiated and how miscellaneous penetrations such as conduits, pipes electric boxes and the like are sealed.

C. Submit manufacturer's product data sheets for each type of membrane, including manufacturer's printed instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, technical data, and tested physical and performance properties.

D. Submit manufacturer's data showing solids content of fluid applied membranes and coverage rates and wet film thickness upon application in order to achieve minimum dry film thickness required by this specification.

E. Submit manufacturer's installation instructions.

F. Submit certification by air/vapor barrier manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

G. Submit certification of compatibility by air/vapor barrier manufacturer, listing all materials on the project that it connects to or that come in contact with it, including sealant as specified in Section 054000 for caulking joints between sheathing panels.

H. Submit samples, 3 by 4 inch minimum size, of each air/vapor barrier material required for Project.

I. Test results of air permeability testing of primary air barrier material (ASTM E 2178-01).

J. Test results of assembly in accordance with ASTM E 2357.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, date of manufacture, and directions for storage.

B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air/vapor barrier manufacturer. Protect stored materials from direct sunlight.

C. Avoid spillage. Immediately notify Owner, Architect if spillage occurs and start clean-up procedures.

D. Clean spills and leave area as it was prior to spill.

1.8 WARRANTY

A. System Warranty: Provide the manufacturer's five (5) year system warranty, including the primary air/vapor barrier and installed accessory sealant and membrane materials which fail to achieve airtight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Subject to compliance with requirements, provide products manufactured by Henry Company.

1. Basis of Design: Henry "Air-Bloc All Weather STPE" or equivalent product by GCP Applied Technologies. Trade names used herein are those of Henry Company.

2.2 MATERIALS

A. Liquid Membrane: Single-component, moisture-curing Silyl Terminated Polyether (STPE) membrane, designed to provide a vapor permeable air and water barrier when applied to above-grade wall assemblies.

1. Color: Black.

B. Adhesives

1. Standard VOC Adhesive: Synthetic rubber based quick setting adhesive; Henry Blueskin Adhesive.

2. Low VOC Adhesive: Synthetic rubber based quick setting adhesive with low VOC content; Henry Blueskin LVC Adhesive.

3. Aerosol Spray Adhesive: Quick drying spray adhesive used to prepare construction surfaces for the application of flashings; Henry Blueskin Spray Prep Adhesive.

C. Quick Setting Primers:

1. Synthetic rubber based quick setting adhesive with low VOC content; Henry Blueskin LVC Spray Primer.

2. Polymer emulsion water based quick setting adhesive with low VOC content; Henry Aquatac Primer.

D. Liquid-Applied Flashing: Moisture-curing, single-component, elastomeric, liquid-applied flashing using Silyl-Terminated Polyether (STPE) polymer curing to a monolithic membrane; Henry Air-Bloc LF Liquid-Applied Flashing.

E. Self-Adhering Flashings

1. Non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of an SBS rubberized asphalt compound integrally laminated to a blue engineered thermoplastic film surface; Henry Blueskin SA Self-Adhered Water Resistive Air Barrier.

2. Low temperature non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of an SBS rubberized asphalt compound integrally laminated to a blue engineered thermoplastic film surface; Henry Blueskin SA LT Low Temp Self-Adhered Water Resistive Air Barrier.

3. At window sills and door thresholds provide high temperature membrane specified in 074113.

F. Sealants

1. Building Envelope Sealant: Moisture cure, medium modulus polymer modified sealing compound; Henry 925 BES Sealant.

2. Termination Sealant: Sealing compound; Henry Polybitume 570-05.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions where fluid-applied air barrier membrane is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected to permit proper installation of the work.

3.2 SURFACE PREPARATION

A. All surfaces must be sound, dry, clean and free of oil, grease, dirt or other contaminants.

B. Joints in sheathing up to 1/2" shall be treated with HE 925 BES Sealant or Air-Bloc LF.

C. Surfaces shall be tied in with beams, columns, etc. using strips of Blueskin SA lapped a minimum of 3" on both substrates. Mechanical attachment should be made to all window and door frames, or a properly designed sealant joint provided.

3.3 TRANSITION MEMBRANE

A. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 3" overlap at all ends and side laps.

B. Tie-in to window frames, metal door frames, etc., and at the interface of dissimilar materials as indicated on the Drawings.

C. Promptly roll all laps and membrane with a countertop roller to effect seal.

D. Ensure all preparatory work is complete prior to applying liquid membrane.

3.4 THROUGH-WALL FLASHING MEMBRANE

A. Align and position the leading edge of self-adhering through-wall flashing membrane with the front horizontal edge of the foundation walls or shelf angles, partially remove protective film and roll membrane over surface and up vertically.

B. Press firmly into place. Ensure minimum 50mm overlap at all end and side laps.

C. Promptly roll all laps and membrane to effect the seal.

D. Ensure all preparatory work is complete prior to applying flashing membrane.

E. Membrane shall form continuous flashing and shall extend up a minimum of 4-1/2" up the back-up wall.

3.5 LIQUID MEMBRANE APPLICATION

A. Apply liquid membrane to wall substrates in a continuous coat at manufacturer’s recommended rate by spray or trowel to provide a minimum wet film thickness of 0.093". Do not use rollers.

1. Minimum dry film thickness shall be 0.078".

2. Apply additional material if surface conditions produce pinholes across the surface.

B. Overlap liquid membrane on to transition membrane at connections a minimum of 1".

C. Trowel liquid membrane around ties and other projections to ensure a complete seal.

D. Do not leave membrane exposed for any longer than 6 weeks.

3.6 PROTECTING AND CLEANING

A. Protect air/vapor barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

C. Protect air/vapor barrier from exposure to the elements as required by the manufacturer.

D. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work using procedures as recommended by manufacturer.

1. Schedule work to ensure that the air and vapor barrier system is covered as soon as possible after installation. Protect air and vapor barrier system from damage during subsequent operations. If the air and vapor barrier system cannot be permanently covered within 30 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

3.7 FIELD QUALITY CONTROL

A. Air Barrier Association of America Installer Audits: Cooperate with ABAA’s testing agency. Allow access to work areas and staging. Notify ABAA in writing of schedule

for Work of this Section to allow sufficient time for testing and inspection. Do not cover Work of this Section until testing and inspection is accepted. Arrange and pay for site inspections by ABAA to verify conformance with the material Manufacturer's instructions, the site Quality Assurance Program used by ABAA, and this section of the project specification.

1. Audits and subsequent testing shall be carried out at the following rate:

    a. Up to 10,000 ft^2 of air barrier contract requires one (1) audit.
    b. 10,001 – 35,000 ft^2 of air barrier contract requires two (2) audits.
    c. 35,001 – 75,000 ft^2 of air barrier contract requires three (3) audits.
    d. 75,001 - 125,000 ft^2 of air barrier contract requires four (4) audits.
    e. 125,001 – 200,000 ft^2 of air barrier contract requires five (5) audits.
    f. 200,001 ft^2 and over of air barrier contract requires six (6) audits.

2. Forward written audit reports to the Architect within 10 working days of the inspection and test being performed.

3. If the inspections reveal any defects, promptly remove and replace defective work at no additional cost to the Owner.

B. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.

2. Remove and replace deficient air-barrier components for retesting as specified above.

C. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

END OF SECTION

SECTION 074113

METAL ROOF PANELS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the metal roof panels as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Standing-seam metal roofing system.

2. Closure, flashing, trim, caps, roof edges, gutter, and related sheet metal work.

3. Supports and accessories, including waterproof membrane.

1.3 RELATED SECTIONS

A. Structural Steel - Section 051200.

B. Carpentry - Section 062000, for wood blocking.

C. Thermal Insulation - Section 072100.

1.4 REFERENCES

A. ASTM B 209, Aluminum and aluminum alloy sheet and plate.

B. ASTM E 1592, Test Method for Structural Performance of Sheet Metal Roofing and Siding Systems by Uniform Air Pressure Difference.

C. SMACNA, "Architectural Sheet Metal Manual."

D. Manufacturer shall have had at least ten (10) years' experience in architectural roofing, and the roof systems shall have been in use for at least ten (10) years. Manufacturer shall demonstrate past experience with examples of projects of similar type and exposure.

E. The installer shall be authorized by the manufacturer, and the actual work shall be supervised by personnel trained by the manufacturer in proper application of the product. The installer shall have capability for preparation of shop details and fabrication of all flashings not furnished by the panel manufacturer.

1.5 SUBMITTALS

A. Shop Drawings: Shop drawings must be in scale large enough to clearly show all details. Include dimensions of fabricated work, reference dimensions to the structure, type, size and spacing of fasteners, material thickness and finishes, plan layout with erection sequence and coordination required with other trades. Shop drawings must be reviewed and approved by the Architect prior to commencement of work.

B. Manufacturer's Data: Submit for information only, metal manufacturer's specifications, installation instructions and general recommendations for roofing applications. Include manufacturer's certification or other data substantiating that the materials comply with the requirements and are adequate to support roof loads as required by Code. Indicate by copy of transmittal that the Fabricator/Installer has received copy of manufacturer's instructions and recommendations.

C. Samples: Submit 12" square samples of each specified metal and gauge to be used on roofing. Samples will be reviewed by Architect for thickness and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

D. Submit certification indicating manufacturer's experience qualifications.

1.6 PERFORMANCE REQUIREMENTS

A. Provide manufactured roof panel assemblies complying with performance requirements indicated and capable of withstanding structural movement, thermally induced movement, and exposure to weather without failure or infiltration of water into the building interior.

B. Metal roof assembly shall be capable of passing ASTM E-1592 testing without failure of any kind when subject to wind uplift pressure as required by Code.

1.7 WARRANTY

A. Upon completion of this portion of the work, and as a condition of its acceptance, deliver to the Architect a written warranty signed by the Roofing Contractor, and endorsed by the roofing materials manufacturer guaranteeing that the installed roofing will remain intact and free from leaks for a period of at least ten (10) years.

B. Paint finish shall have a twenty (20) year guarantee against cracking, peeling and fade.

1.8 PRODUCT HANDLING

A. Protection: Protection shall be provided during fabrication, shipment, storage and erection. During shipment, finished surfaces shall be protected from abrasion by a removable plastic film between areas of contract. Job site storage shall be in a clean, dry area out of direct contact with the ground, under cover or sloped for drainage, protected from abuse by traffic and from contamination by corrosive or staining materials. Stored materials and unfinished work shall be secured against wind damage. Installed panels shall be protected from abuse by other trades.

PART 2 PRODUCTS

2.1 METAL ROOFING

A. Standing Seam Metal Roof: Metal roof shall be mechanically seamed, standing seam as manufactured by ATAS International, Inc., Berridge Manufacturing Co., Engelert, Petersen Aluminum Corp., or approved equal.

B. Material: Provide zinc-coated (galvanized) steel sheet complying with ASTM A653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755.

1. Thickness: 22 gauge minimum.

C. Finish shall be two-coat fluoropolymer conforming to AAMA 621; fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color: As selected by the Architect.

D. Roof panels shall be factory-formed and the panel assembly designed for concealed mechanical attachment of panels to metal channels.

1. Provide minimum 0.0625" thick, stainless-steel panel clips designed to meet negative load requirements.

2. Mechanically seamed cleats formed from minimum 0.0250" thick, stainless steel sheets.

E. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96" long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36" o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

F. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing, window sills and door thresholds. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.

2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.

3. Acceptable Products: Henry Co. "Blueskin PE 200HT," or approved equal.

G. Polyisocyanurate Board Roof Insulation, Nailable: Provide rigid, cellular thermal insulation with polyisocyanurate closed-cell foam core bonded to 7/16" thick OSB on the top side and a fiber-reinforced felt facer on the bottom side; equal to "ACFoam Nail Base" as manufactured by Atlas Roofing Company, or equal, complying with ASTM C 1289, Type V, average LTTR value as designated at mean temperatures indicated after testing per ASTM C 1303 as follows:

1. LTTR R-Value: 6.0/inch at 75 deg. F.

2. Surface Burning Characteristics: Maximum flame spread of 25.

H. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring. Provide seam-mounted, stop-type snow guards fabricated of cast aluminum designed for attachment to vertical ribs of standing-seam metal roof panels with stainless-steel set screws. Provide products manufactured by Berger Building Products or approved equal.

2.2 MISCELLANEOUS MATERIALS

A. Provide components required for a complete roof panel assembly including trim, copings, fascia, mullions, sills, corner units, ridge closures, clips, seam covers, battens, flashings, gutters, sealants, gaskets, fillers, closure strips, and similar items. Match materials and finishes of panels.

1. Closure Strips: Closed-cell, self-extinguishing, expanded, cellular, rubber or cross-linked, polyolefinfoam flexible closure strips. Cut or premold to match configuration of panels. Provide closure strips where indicated or necessary to ensure weathertight construction.

2. Sealing Tape: Pressure sensitive, 100 percent solids, polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, non-sag, non-toxic, non-staining tape.

3. Elastomeric Joint Sealant: ASTM C 920, of base polymer, type, grade, class, and use classifications required to seal joints in panel roofing and remain weathertight. Provide sealant recommended by panel manufacturer.

B. Fasteners shall be self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Use stainless steel fasteners for all exterior applications and galvanized steel fasteners for interior applications.

C. Bituminous coating shall be cold applied asphalt mastic, SSPC - Paint 12, compounded for 15 mil dry film thickness per coat. Provide inert type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 PANEL SUPPORTS AND ANCHORAGE

A. Secondary Framing: Provide components complying with the Light Gage Structural Institute's "Guide Specifications," and "Manufactured Roof and Wall Panels."

B. Roof Purlins: C- or Z-shaped sections fabricated from 0.0598" thick (16 gauge), shop painted, roll-formed steel. Purlin spacers fabricated from 0.079" thick, cold-formed, galvanized steel sections.

C. Eave Struts: Unequal flange, C-shaped sections formed to provide adequate back-up for roof panels. Fabricate from 0.0598" thick, shop-painted, roll formed steel.

D. Flange and Sag Bracing: 1-5/8" by 1-5/8" angles, fabricated from 0.0598" thick, shop painted, roll-formed steel.

2.4 FABRICATION

A. Comply with dimensions, profile limitations, gauges and fabrication details shown on drawings and specified herein.

B. Fabricate components of the system in factory, ready for field installation.

C. Fabricate components and assembly units to comply with performance requirements specified.

D. Apply specified finishes in conformance with manufacturer's standards, and according to manufacturer's instructions.

E. In addition to requirements specified herein or shown on drawings, all surfaces exposed to view shall be clean, and free from dirt, stains, grease, scratches, distortions, waves, dents, buckles, tool marks, burrs and other defects which mar appearance of finished work. Metal work exposed to view shall be straight and true to line or curve, smooth arrises and angles as sharp as practicable, miters formed in true alignment, profiles accurately intersecting, and with joints carefully matched to produce continuity of line and design. Exposed fastenings, where permitted, shall be of the same material, color and finish as the metal to which applied, unless otherwise indicated, and shall be of the smallest practicable size.

F. Materials used shall be of such strength, thickness and alloy that they are capable of meeting all standards and descriptions specified herein and as detailed on drawings.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where metal roof panels are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for assembly, installation and erection of roof systems.

B. Metal Separation: Apply a coat of bituminous paint, concealed, on one or both surfaces wherever dissimilar metals would otherwise be in contact.

C. Anchor component parts securely in place, providing for necessary thermal and structural movement.

D. Joint Sealers: Install gaskets, joint fillers and sealants where required for weatherproof performance of system. Provide type of gaskets and sealants/fillers recommended by manufacturer.

E. Installation of Metal Roof Panels

1. Conform to standards set forth in the SMACNA architectural sheet metal manuals and manufacturer's recommendations.

2. Install panels so that they are weathertight, without waves, warps, buckles or distortions, and allow for expansion and contraction.

3. Caulk all flashing and panel joints that require caulking to prevent water penetration.

4. Seam panels together with electric powered seaming machine supplied by the manufacturer to ensure a weathertight seam.

5. Remove any strippable film immediately upon installation.

F. Damaged Material: Remove and replace panels and component parts of the work which have been damaged (including finish) beyond successful repair, as directed by the Architect. Repair minor damage.

G. Clean exposed surfaces of metal panels promptly after completion of installation. Comply with recommendations of the manufacturer.

END OF SECTION

SECTION 075419

POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the thermoplastic membrane roofing as shown on the drawings and specified herein, including, but not limited to, the following:

1. PVC sheet membrane roofing, fully adhered.
2. Walkway pads.
3. Associated flashing.
4. Accessories.
5. Pavers on pedestals; refer to Landscape Drawings.
6. Decorative gravel ballast.

1.1 RELATED SECTIONS

A. Sheet Metal Flashing - Section 076200.

B. Roof drains - Division 23.

1.2 QUALITY ASSURANCE

A. Installer: A firm with not less than 5 years of successful experience in installation of roofing systems similar to those required for this project and which is acceptable to or licensed by the manufacturer of the primary roofing materials. The roofing installer shall be authorized to install the roofing system prior to bid.

B. UL Listing: Provide labeled materials which have been tested and listed by UL for application indicated and which have a Class “A” rating.

C. Membrane to have no formulation changes in the last 15 years as certified by the manufacturer.

D. Roof system have Energy Star rating.

E. Roof System shall conform to FM Standards and meet prevailing codes for wind uplift, and ASCE-7, whichever is more restrictive.

1.3 SUBMITTALS

A. Submit material samples for all products listed, and certifications for roofing materials.

1. Submit 5 lb. bag of gravel ballast.

B. Submit complete shop drawings showing details, dimensions, colors, fabrication and fastening elements for each condition encountered, layout of sloped concrete topping, layout of flat and tapered insulation, showing all seams, layout of each sheet noting seam locations, perimeter and penetration flashing and other details where roofing abuts other materials and/or conditions, prior to roofing conference. Show all flashing, with exact profile with dimensions, joints, terminations, and methods of attachment.

C. Submit notarized letter indicating that roofing Subcontractor is an approved applicator of the manufacturer fir the roofing system specified on the Project.

D. Submit a letter signed by the manufacturer and Contractor acknowledging that the submitted roofing system complies with ASCE-7 and wind loads noted.

E. Submit calculations to verify cover board attachment will withstand code-defined wind loads.

1.4 PREROOFING CONFERENCE

A. Prior to ordering of materials, a pre-roofing conference will be held to discuss the specified roofing system, its proper application, and procedures to avoid roofing damage by other trades. Conference shall include installer, Roofing Foreman, roofing manufacturer, installers of related work, Architect and representatives of Owner. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to participants prior to convening conference.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type, and brand. Delivered materials shall match approved samples. Fire classification labels shall be intact and visible.

B. Store materials under cover in a dry and clean location, off the ground and remove materials which are damaged, torn or otherwise not suitable for installation and replace with acceptable materials.

C. Keep insulation and membrane dry, before and during installation. Remove wet materials from project site.

D. Store roofing materials on platforms or pallets, above ground on roof level and cover with tarpaulins or on other suitable watertight covering. Store membrane, and handle, in such a way as to prevent damage to edges or ends. Follow the manufacturer’s requirements for storage of materials under specific weather conditions that may affect the materials.

E. All materials that are determined by the Architect or the Roofing Manufacturer to be damaged are to be removed from the site and replaced at no cost to the Owner.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Work shall not be installed when the roof deck is damp, wet or spotted with frost or if the ambient temperature is 40 deg. F. or less and falling or if there is a forecast for inclement weather which will be adverse to the proper installation of the roofing system.

B. Coordinate application of the roofing system in such a manner that the complete installation is weather-tight and in accordance with guarantee requirements.

1.7 WARRANTY

A. Provide 25 years (NDL) System Warranty from date of substantial completion for the roofing work as specified in this Section. Warranty shall protect the Owner against the costs of repairing leakage resulting

from building defects in all components of the system supplied to include membrane, fasteners, and insulation, as well as from defects in the workmanship involved in their installation.

B. Applicator/Roofing Contractor Warranty: The Applicator shall supply the Owner with a separate two-year workmanship warranty from date of substantial completion. In the event any work related to roofing, flashing, or metal is found to be within the Applicator warranty term, defective or otherwise not in accordance with the Contract Documents, the Applicator shall repair that defect at no cost to the Owner. The Applicator's warranty obligation shall run directly to the Owner, and a copy shall be sent to the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Provide PVC sheet roofing and flashing system as manufactured by one of the following, or approved equal:

1. Sarnafil G410 Feltback Adhered System (basis for project design).
2. Johns Manville.
3. GAF.

2.2 ROOF MEMBRANE

A. Provide 80 mil PVC non-woven fiberglass reinforced fabric-backed roof membrane with a lacquer coating, No. G410 Feltback as manufactured by Sarnafil; membrane conforming to ASTM D 4434, Type III, Grade 1.

1. Membrane Color: As selected by Architect from manufacturer’s standard range.

2.3 VAPOR BARRIER

A. Self-Adhered Vapor Barrier: Sarnavap, 32 mil self-adhered vapor barrier as manufactured by Sarnafil, or approved equal.

2.4 FLASHING MATERIALS

A. Wall/Curb Flashing

1. G410 Membrane: Fiberglass reinforced membrane adhered to approved substrate using adhesive.
2. Clad Metal: A PVC-coated, heat-weldable sheet metal capable of being formed into a variety of shapes and profiles. Clad metal is a 25 gauge, galvanized steel sheet with a 20 mil unsupported membrane laminated on one side.

B. Perimeter Edge Metal Flashing

1. Clad Metal: Same as above for Wall/Curb Flashing.
2. Non-Typical Edge: Project-specific perimeter edge detail reviewed and accepted for one-time use by the manufacturer.
3. Flashing: 26 gauge, stainless steel type 304, 2D finish.

C. Miscellaneous Flashing

1. Reglet: A heavy-duty, extruded aluminum flashing termination reglet used at walls and large curbs. Reglet is produced from 6063-T5, 0.10” - 0.12” thick extruded aluminum. Reglet has a 2-1/2” deep profile, and is provided in 10 foot lengths. Use prefabricated Reglet mitered inside and outside corners where walls intersect.

2. Multi-Purpose Sealant: Sikaflex; a sealant used at flashing and drain terminations.

3. Felt: A non-woven polyester or polypropylene mat cushion layer that is necessary behind G410 when the flashing substrates are rough-surfaced or incompatible with the flashing membrane.

4. Provide other flashing materials as needed to conform to drawings and shop drawings.

2.5 INSULATION AND COVER BOARD

A. Insulation shall be installed in multiple layers to obtain required thermal value.

1. Insulation shall meet all identified code requirements.

2. Insulation shall be approved in writing by the insulation manufacturer for intended use, and for use with Sarnafil materials.

3. Insulation shall be compatible with Sarnafil membrane.

4. Product: Sarnatherm isocyanurate insulation with fiberglass facers, supplied by Sarnafil Inc.

B. Insulation shall be tapered (1/4"/ft., unless otherwise indicated; and flat rigid board type designed for roof application.

1. Provide tapered insulation crickets at 1/4” per foot where indicated on drawings.

2. Provide tapered insulation at drains to create sump.

3. Provide tapered insulation along base of all walls to shed water away from wall.

4. Contractor shall have the option of using graduated shims at 12’ o.c. s an option to suing tape insulation in order to achieve a smooth and continuous curve.

C. Roof insulation shall be of sufficient thickness to achieve a minimum “R” value of 30 at 75 deg. F, but not less than 4" thick.

D. Cover Board: ASTM C 1177, glass-mat, water-resistant gypsum substrate, 5/8" thick, equal to "Dens Deck" by Georgia-Pacific Corporation.

1. Outdoor Roof Deck and Institute Roof: Cover board on tapered insulation.

2. Outdoor Roof Deck: Cover board over metal deck.

E. Insulation Attachment: Provide corrosion resistant fasteners for penetration into substrates as shown on drawings, specified herein and recommended by the insulation manufacturer. At concrete decks use two-component urethane adhesive approved by Saranfil and insulation manufacturer.

1. Fasteners and plates shall be supplied by Sarnafil.

2. Adhesive for insulation shall be OlyBond 500 two component urethane as supplied by Sarnafil.

F. Cover Board Attachment: Provide corrosion-resistant fasteners for penetration into project substrates as shown on drawings, specified herein, and recommended by the insulation manufacturer.

1. Fastener and plates shall be approved in writing by the fastener manufacturer for intended use, and for use with Sarnafil products.

2. Cover Board Attachment: OlyBond 500 two-component urethane supplied by Sarnafil to attach cover board to insulation.

3. Fasteners must be FM approved and shall be spaced in accordance with applicable FM Approval Guide.

2.6 ATTACHMENT COMPONENTS

A. Membrane Adhesive, Insulation and Cover Board Adhesive

1. OlyBond 500 Adhesive (for insulation to self-adhered vapor barrier at concrete deck and for cover board to insulation). Two-component low-rise urethane foam adhesive used to adhere insulation to self-adhered vapor barrier at concrete deck and for cover board to insulation.

2. Sarnacol 2170 VC Solvent Compliant Adhesive for adhering PVC to cover board.

B. Plate: Used with various fasteners to attach insulation board to wood deck. Plate is a 3” square or round, 26 gauge stamping of SAE 1010 steel with an AZ 55 Galvalume coating.

C. Fastener #12: A #12 corrosion-resistant fastener used with Plates to attach insulation boards to wood roof deck. Fastener #12 has a modified buttress thread, a shank diameter of approximately 0.168” and a thread diameter of approximately 0.214”. The driving head has a diameter of approximately 0.435” with a #3 Phillips recess for positive engagement.

D. Fastener-HD: A #14 corrosion-resistant fastener used with Plate-HD/CD to attach insulation boards or with Disc and Bar to attach membrane to structural concrete roof deck. Fastener-HD has a shank diameter of 0.190”, a thread diameter of 0.245” and a #3 Phillips drive head with a diameter of 0.435”.

E. Fastener-XP: A #15, heavy-duty, corrosion-resistant fastener used with Plate to attach insulation or Stop and Bar to attach G410 roof membrane to wood roof deck. Fastener-XP has a shank diameter of approximately 0.21” and the thread diameter is approximately 0.26”. The driving head has a diameter of approximately 0.435” with a #3 Phillips recess for positive engagement.

F. Fastener-XPS: A specially designed, heavy-duty, corrosion-resistant fastener used with Stop or Bar to attach G410 roof membrane to wood roof decks. Fastener-XPS has a shank diameter of approximately 0.21” and a thread diameter of approximately 0.26”. The driving head has a diameter of approximately 0.435” with a #3 Phillips recess for positive engagement and simplicity of application.

G. Stop: An extruded aluminum, low profile bar used with certain Fasteners to attach to the roof deck or to walls/curbs at terminations, penetrations and at incline changes of the substrate. Stop is a 1” wide, flat aluminum bar 1/8” thick that has predrilled holes every 6” on center.

H. Bar: An FM-approved, heavy-duty, 14 gauge, galvanized or stainless, roll-formed steel bar used to attach membrane to roof decks. The formed steel is pre-punched with holes every 1” on center to allow various Fastener spacing options.

I. Cord: A 5/32” diameter, red-colored, flexible thermoplastic extrusion that is welded to the top surface of the membrane and against the side of the Bar, used to hold the membrane in position.

2.7 MISCELLANEOUS ACCESSORIES

A. Aluminum Tape: A 2" wide pressure-sensitive aluminum tape used as a separation layer between small areas of asphalt contamination and the membrane and as a bond-breaker under the cover strip at Clad joints.

B. Sealing Tape Strip: Compressible foam with pressure-sensitive adhesive on one side. Used with metal flashings as a preventive measure against air and wind-blown moisture entry.

C. Multi-Purpose Tape: A high performance sealant tape with used with metal flashings as a preventive measure against air and wind-blown moisture entry.

D. Welder 641mc: 220 volt, self-propelled, hot-air welding machine used to seal long lengths of membrane seams.

E. Perimat Welder: 120 volt, self-propelled, hot-air welding machine used to seal long-lengths of membrane seams along perimeter details.

F. Solvent: A high quality solvent cleaner used for the general cleaning of residual asphalt, scuff marks, etc., from the membrane surface. Solvent is also used daily to clean seam areas prior to hot-air welding in tear off or dirty conditions or if the membrane is not welded the same day it is unrolled.

G. Provide non-corrosive accessories required to accommodate lighting protection devices and snow-melt systems.

H. Walkway: Provide "Crossgrip Walkway," rolled-out walkway protection mat as manufactured by Sarnafil, or approved equal; 9/16" inch thick flexible PVC with a heavily textured surface, loose laid on top of completed roof assembly. Provide premolded inside and outside corners and T-joint covers as provided by Sarnafil.

I. Pavers on Pedestals: Refer to Landscape Documents.

J. Below pavers and pedestal provide Geonet B drainage panel by Sarnafil.

K. Gravel Ballast: Well-screened and washed stone gravel meeting ASTM D 448, gradation No. 5, 4 and 2.

L. Below gravel provide PVC protection Layer.

2.8 MISCELLANEOUS FASTENERS AND ANCHORS

A. All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum or stainless steel. Mixing metal types and methods of contact shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins. All concrete fasteners and anchors shall have a minimum embedment of 1-1/2" and shall be approved for such use by the fastener manufacturer. All miscellaneous wood fasteners and anchors used for flashings shall have a minimum embedment of 1-1/2" and shall be approved for such use by the fastener manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. Coordinate the installation so that each area is made watertight at the end of each work period.

B. Notify Architect of any discrepancies between drawing and field conditions.

C. The substrate shall be smooth, level, and free from moisture or frost. Sharp ridges or other projections above the surface shall be removed before application of roofing and flashing.

3.2 SUBSTRATE CONDITION

A. Applicator shall be responsible for acceptance or provision of proper substrate to receive new roofing materials.

B. Applicator shall verify that the work done under related sections meets the following conditions:

1. Roof drains and/or scuppers have been installed properly.

2. Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new roofing materials.

3. All surfaces are smooth and free of dirt, debris and incompatible materials.

4. All roof surfaces shall be free of water, ice and snow.

3.3 SUBSTRATE PREPARATION

A. The roof deck construction must be structurally sound to provide support for the roof system. The Applicator shall load materials on the rooftop in such a manner to eliminate risk of deck overload due to concentrated weight.

B. The roof substrate shall have a smooth and level surface and shall be free of dust, excess moisture, oils, and loose debris. Sharp ridges or other projections above the surface shall be removed before roofing is applied.

3.4 SUBSTRATE INSPECTION

A. A dry, clean and smooth substrate shall be prepared to receive the adhered roof system.

B. Inspect the substrate for defects such as excessive surface roughness, contamination, structural inadequacy, or any other condition that will adversely affect the quality of work.

3.5 WOOD NAILER INSTALLATION

A. Install continuous preservative treated wood nailers at roof projections and penetrations as required by membrane manufacturer and between insulation spaced as required for cover board and roof membrane attachment. Refer to detail drawings for attachment of roofing membrane at parapet wall, skylight, mechanical room, etc.

B. Nailers shall be anchored to resist a minimum force of pullout loads due to wind loads, as required by code, in any direction. Individual nailer lengths shall not be less than 3 feet long. Nailer fastener spacing shall be at 12” on center or 16” on center if necessary to match the structural framing. Fasteners shall be staggered 1/3 the nailer width and installed within 6” of each end. Two fasteners shall be installed at ends of nailer lengths. Nailer attachment shall meet this requirement and that of the current Factory Mutual Loss Prevention Data Sheet 1-49.

C. Thickness shall be as required to match substrate or insulation height to allow a smooth transition.

3.6 SELF-ADHERED VAPOR BARRIER

A. Install Sarnavap Self-Adhered over a clean and dry substrate. Do not install when it is raining, snowing, or on wet/humid surfaces. Install in temperatures 32 deg F and above. The use of a primer is required on the

following substrates: wood, concrete, lightweight concrete, gypsum boards and decks, and Dens Deck boards. On metal decks, use Dens Deck. Do not install vapor barrier directly on metal flutes.

B. Terminate vapor retarder at perimeters and penetrations as detailed in accordance with the manufacturer's recommendations.

3.7 INSULATION AND SEPARATION BOARD INSTALLATION

A. General Criteria:

1. Insulation and Separation Board shall be installed according to insulation manufacturer's instructions.

2. Insulation and Separation Board shall be neatly cut to fit around penetrations and projections.

3. Install tapered insulation in accordance with insulation manufacturer's shop drawings.

4. Install tapered insulation around drains creating a drain sump.

5. Do not install more insulation board than can be covered with membrane by the end of the day or the onset of inclement weather.

6. Arrange insulation boards staggered at the end of each day's work, to provide continuity of staggered joints between adjacent work areas.

7. Use at least 2 layers of insulation when the total insulation thickness exceeds 2-1/2". Stagger joints at least 12" between layers.

8. Mechanical Attachment

a. Insulation and separation boards shall be mechanically fastened to treated wood blocking with approved fasteners and plates at a rate according to the insulation manufacturer's, FM's and the manufacturer's recommendations for fastening rates and patterns. Use minimum fifteen fasteners per 4' x 8' board and additional 50% at the perimeter and 75% at corners. The quantity and locations of the fasteners and plates shall also cause the insulation boards to rest evenly on the roof deck/substrate so that there are no significant and avoidable air spaces between the boards and the substrate. Each insulation board shall be installed tightly against the adjacent boards on all sides.

b. Use fastener tools with a depth locator and torque-limiting attachment as recommended or supplied by fastener manufacturer to ensure proper installation.

9. Adhesive Installation of Cover Board and Insulation: Insulation and cover board at the concrete decks shall be installed using OlyBond 500 two component urethane adhesive.

3.8 INSTALLATION OF MEMBRANE

A. The surface of the insulation or substrate shall be inspected prior to installation of the roof membrane. The substrate shall be clean, dry, free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation boards shall be removed and replaced.

1. Install PVC membrane in accordance with manufacturer's printed instructions except as modified herein.

2. Workmen and others that walk on the waterproofing membrane shall wear soft clean soled shoes as not to damage materials.

3. Use maximum size sheets to reduce number of joints in system.

4. Adhere Sanafelt to all surfaces with asphalt residue or other contaminants using the manufacturer's recommended adhesive. Keep lap with deck sheet or reinforcing sheet sheet free of adhesive. Place sheets in position and fold back on itself so one half of the underside of the sheet is exposed. Apply adhesive to the substrate and membrane as directed by manufacturer. Roll sheets onto approved substrate with neoprene covered rollers. Repeat for second half of the sheet. Keep adhesive away from lap areas.

5. Lap previous sheet a minimum of 4 inches weld laps using Sarnafil approved electric hot air welding devices. Test all welds for conformity to specifications by running a metal "pick" along all welds after welds have cooled. Any openings or discontinuities shall be rewelded. Positive evidence of welding is a characteristic uninterrupted extrusion of melted (black) material from the joint.

6. T-Joint (3 way overlaps): When welding a 3 way overlap the top edge of the second sheet shall be shaved down to create a smooth transition for the top membrane layer to conform to for welding. Chamfer the edge of the membrane using a handheld grinder or joint planer by manufacturer.

7. Test Cuts: At least two cross section test cuts, 2 inches wide through welded seams shall be made daily as directed by manufacturer. Correct field welds will fail from shearing of the membrane prior to separating of the welds. Patch areas of test at no additional cost to Owner.

8. Provide supplemental perimeter attachment with wind resistance bar factored at 12 inches on center around perimeter of roof by fastening bar through membrane. Install membrane cover strip over bar and provide minimum 4 inches wide hot air welded seam (3 inches for machine welding) all around bar in accordance with manufacturer's specifications.

9. Sarnacol 2170 Adhesive: Over the properly installed and prepared substrate, install 2170 adhesive in accordance with manufacturer's written instructions.

B. At locations where sleepers for wood deck rest on membrane, weld another layer of membrane underneath all sleepers. Exceed the sleeper width by 6".

3.9 HOT-AIR WELDING OF SEAM OVERLAPS

A. General

1. All seams shall be hot-air welded. Seam overlaps should be 3" wide when automatic machine-welding and 4" wide when hand-welding, except where specified or shown on drawings.

2. Welding equipment shall be provided by or approved by the manufacturer. All mechanics intending to use the equipment shall have successfully completed a training course provided by he manufacturer prior to welding.

3. All membrane to be welded shall be clean and dry.

B. Hand-Welding: Hand-welded seams shall be completed in two stages. Hot-air welding equipment shall be allowed to warm up for at least one minute prior to welding.

1. The back edge of the seam shall be welded with a narrow but continuous weld to prevent loss of hot air during the final welding.

2. The nozzle shall be inserted into the seam at a 45 degree angle to the edge of the membrane. Once the proper welding temperature has been reached and the membrane begins to "flow," the hand roller is positioned perpendicular to the nozzle and pressed lightly. For straight seams, the 1-1/2" wide nozzle is recommended for use. For corners and compound connections, the 1/4" wide nozzle shall be used.

C. Machine Welding

1. Machine welded seams are achieved by the use of the automatic welding equipment. When using this equipment, instructions shall be followed and local codes for electric supply, grounding and over current protection observed. Dedicated circuit house power or a dedicated portable generator is recommended. No other equipment shall be operated off the generator.

2. Metal tracks may be used over the deck membrane and under the machine welder to minimize or eliminate wrinkles.

D. Quality Control of Welded Seams: The Applicator shall check all welded seams for continuity using a rounded screwdriver. Visible evidence that welding is proceeding correctly is smoke during the welding operation, shiny membrane surfaces, and an uninterrupted flow of dark grey material from the underside of the top membrane. On-site evaluation of welded seams shall be made daily by the Applicator to locations as directed by the Architect or the manufacturer's representative. 2" wide cross-section samples of welded seams shall be taken at least 3 times a day. Correct welds display failure from shearing of the membrane prior to separation of the weld. Each test cut shall be patched by the Applicator at no extra cost to the Owner.

3.10 MEMBRANE FLASHINGS

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Architect and the manufacturer. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Applicator's expense. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution to ensure adhesive fumes are not drawn into the building.

1. Adhesive for Membrane Flashings

a. Over the properly installed and prepared flashing substrate, adhesive shall be applied according to instructions found on the Product Data Sheet. The adhesive shall be applied in smooth, even coats with no gaps, globs or similar inconsistencies. Only an area which can be completely covered in the same day's operations shall be flashed. The bonded sheet shall be pressed firmly in place with a hand roller.
b. No adhesive shall be applied in seam areas that are to be welded. All panels of membrane shall be applied in the same manner, overlapping the edges of the panels as required by welding techniques.

2. Install Stop/Bar/Cord according to the Detail Drawings and manufacturer's instructions with approved fasteners into the preservative treated wood blocking at the base of parapets, walls and curbs. Stop is required by the manufacturer at the base of all tapered edge strips and at transitions, peaks, and valleys according to manufacturer's details.

3. Manufacturer's requirements and recommendations and the specifications shall be followed. All material submittals shall have been accepted by the manufacturer prior to installation.

4. All flashings shall extend a minimum of 8" above roofing level unless otherwise accepted in writing by the Architect and membrane manufacturer and as shown on the Contract Drawings.

5. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded into place. No bitumen shall be in contact with the membrane.

6. All flashing membranes shall be mechanically fastened along the counter-flashed top edge with Stop at 6" - 8" on center.

7. Flashings shall be terminated according to manufacturer's recommended details.

8. All flashings that exceed 30" in height shall receive additional securement as recommended by membrane manufacturer

3.11 METAL FLASHINGS

A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:

1. Factory Mutual Loss Prevention Data Sheet 1-49 (latest issue).

2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

B. Metal, other than that provided by the manufacturer, is not covered under the membrane warranty.

C. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.

D. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.

E. Joints in the copper or stainless steel counter flashings shall be riveted and soldered watertight.

F. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood nailer a minimum of 1".

G. Airtight and continuous metal hook strips are required behind metal fascias. Hook strips are to be fastened 12" on center into the wood nailer or masonry wall.

H. Counter flashings shall overlap base flashings at least 4".

I. Hook strips shall extend past wood nailers over wall surfaces by 1-1/2" minimum and shall be securely sealed from air entry.

3.12 CLAD METAL BASE FLASHINGS/EDGE METAL

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Architect and the manufacturer. Acceptance shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Applicator's expense.

1. Clad edge metal flashings shall be formed and installed per the detail Drawings.

a. All metal flashings shall be fastened into solid wood nailers with two rows of post galvanized flat head annular ring nails, 4" on center staggered. Fasteners shall penetrate the nailer a minimum of 1".
b. Metal shall be installed to provide adequate resistance to bending and allow for normal thermal expansion and contraction.
c. Edge metal to have 90 degree break angle on both sides to form 1/2" for exposed condition.

2. Adjacent sheets of clad metal shall be spaced 1/4" apart. The joint shall be covered with 2" wide aluminum tape. A 4" minimum wide strip of flashing membrane shall be hot-air welded over the joint.

3.13 TEMPORARY CUT-OFF

A. All flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses. All temporary waterstops shall be constructed to provide a 100% watertight seal. The stagger of the insulation joints shall be made even by installing partial panels of insulation. The new membrane shall be carried into the waterstop. The waterstop shall be sealed to the deck and/or substrate so that water will not be allowed to travel under the new or existing roofing. The edge of the membrane shall be sealed in a continuous heavy application of sealant as described in above. When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers, etc. shall be removed from the work area and properly disposed of off site. None of these materials shall be used in the new work.

B. If inclement weather occurs while a temporary waterstop is in place, the Applicator shall provide the labor necessary to monitor the situation to maintain a watertight condition.

C. If any water is allowed to enter under the newly-completed roofing, the affected area shall be removed and replaced at the Applicator's expense.

3.14 BALLASTING

A. Where indicated, set pavers on pedestals following manufacturer's instructions; provide 3/16" open joint between pavers and support each corner of paver on a pedestal. Adjust paver height to proper elevation using accessories that come with paver pedestal system.

B. Where loose gravel ballast is indicated, spread evenly at the rate of 20 lbs./sq. ft.

C. Provide specified protection layers below ballasting.

3.15 COMPLETION

A. Prior to demobilization from the site, the work shall be reviewed by the Architect and the Applicator. All defects noted and non-compliances with the Specifications or the recommendations of the manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Applicator to the satisfaction of the Architect and the manufacturer prior to demobilization.

B. All Warranties referenced in this Specification shall have been submitted and have been accepted at time of contract award.

END OF SECTION

SECTION 076200

SHEET METAL FLASHING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the sheet metal flashing as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Stainless steel cap metal flashing.

2. Stainless steel scuppers.

3. Field fabricating (including bending, cutting, soldering, etc.), if required, of stainless steel flashing.

4. Stainless steel flashing elsewhere, where metal flashing is indicated on drawings.

5. Separation of contacting surfaces of dissimilar metals.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Exterior Stone Cladding - Section 044200.

C. Roofing - Division 7.

1.4 SUBMITTALS

A. Shop Drawings: Submit, showing all materials, finishes, fastenings, joint details, fabrication, construction and relation to adjoining construction.

B. Samples: Submit 12" x 12" samples of flashing materials and finishes.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

1.6 WARRANTY

A. The Contractor shall warrant that all Metal Flashing Work executed under this Section will be free from defects in materials and workmanship for a period of ten (10) years from date of acceptance of the Project, and he shall remedy any defects in the Metal Flashing Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stainless Steel Flashing Materials

1. Stainless Steel Flashing: ASTM A 240, Type 304, stainless steel, with 2D finish, dead soft temper, fully annealed, as manufactured by International Nickel Co., Republic Steel Corp., United States Steel, or Washington Steel Corp. Thickness of stainless steel shall be as listed below.

a. Concealed Flashings: 0.012" thick, thirty (30) gauge (U.S. Standard).
b. Exposed Flashings: 0.015" thick, twenty-eight (28) gauge (U.S. Standard).
c. Edge Strips: 0.025" thick, twenty-four (24) gauge (U.S. Standard).

2. Accessories and Fastenings: AISI, Types 302 and 304 stainless steel.

3. Solder: Composed of sixty (60) percent block tin and forty (40) percent pig lead, except that solder at seams exposed to public view shall be eighty (80) percent tin and twenty (20) percent lead.

4. Flux: An acid type flux manufactured specifically for soldering stainless steel, as approved.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where sheet metal flashing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 METAL FLASHING INSTALLATION

A. Reference Standard: Conform to the requirements of 7th Edition of the Sheet Metal and Air Conditioning Contractors Association (SMACNA) Architectural Sheet Metal Manual.

B. General: Fabricate and install metal flashing work in accordance with details and specifications of above Reference Standard, with manufacturer's instructions, and as herein specified, to provide a watertight installation. Apply metal flashing to smooth, even, sound, clean, dry surfaces free from defects. Make provisions to allow for expansion and contraction of metal flashing work. Wherever practicable, shop form all metal flashing work and deliver ready for installation. Form metal flashing work accurately to required profiles, with flat surfaces, straight edges and corners, free from defects. Fold exposed metal edges back not less than 1/2" and form drip.

C. Nailing: Confine to sheets twelve (12) inches or less in width. Confine nailing to one edge only, locate nails where concealed. Use No. 12 x 1" long flat headed, annular threaded, Type 302 stainless steel nails for nailing to wood blocking; use one (1) inch long masonry nails for nailing to concrete. Space nails four (4) inches o.c. maximum.

D. Cleating: Use cleats where sheets are more than twelve (12) inches in width. Space cleats approximately twelve (12) inches o.c. Cleats two (2) inches wide by three (3) inches long, of the same material and weight as the metal flashing being installed. Secure one end of the cleat with two (2) nails and fold edge back over the nail heads. Lock other end into seam or into folded edge of metal flashing sheets. Pre-tin cleats for soldered seams.

E. Joining: Join metal flashings with one (1) inch locked and soldered seams except at slip joints. Mallet seams flat and solder full length of seam as specified below.

F. Soldering: Clean and pre-tin edges of metal flashing to be soldered before soldering is begun with solder on both sides for a width of not less than 1-1/2". Solder slowly with well heated metal surfaces. Use ample solder. Show not less than one full inch of evenly flowed solder on seam. Seams shall have a liberal amount of flux brushed in before soldering is commenced. Where soldering paste or killed acid is employed as a flux, soldering shall follow immediately after application of the flux. Upon completion of soldering, clean surfaces of all flux.

G. Slip Joints: Locate slip joints not more than twenty-four (24) feet apart and not more than eight (8) feet from corners. Form slip joints as three (3) inch wide joints with cover piece behind flashing and fill locked ends neatly with sealant.

H. Cap Flashing: Install over base flashings, in eight (8) to ten (10) foot lengths, lapped six (6) inches at ends. Cap flashing shall be increased longitudinally to produce spring action to hold bottom edge of cap flashing firmly against base flashing. Cap flashing shall lap base flashing at least four (4) inches, with exposed bottom edge at a forty-five (45) degree angle downward and folded back on underside at least 1/2" to form drip. Make cap flashing continuous at corners and angles.

I. Miscellaneous Flashing: Provide all other miscellaneous metal flashing not specifically mentioned herein but indicated on drawings and/or required to provide a watertight installation.

J. Separation of Dissimilar Materials: Back paint surfaces of metal flashing in contact with dissimilar metals or with concrete or masonry with bituminous paint.

K. Reglets

1. Provide watertight reglets in masonry and concrete work to receive cap flashing. Form reglets of stainless steel using same thickness as stainless steel sheet metal specified.

2. In masonry work use open or closed slot reglets with slat at least one (1) inch deep and 3/16" wide. Provide hook dams or turn-ups for anchoring securely into mortar joints. Insert cap flashing into slot full depth using button punch or lead wedges to lock in place.

3. In concrete work, use open or closed slot reglets with slot sloped upward at forty-five (45) degrees, at least one (1) inch deep and 3/16" wide. For fastening reglets to concrete forms use double-head stainless steel nails spaced twelve (12) inches apart maximum.

4. Insert cap flashing full depth into reglet slot, and wedge in place using lead strips spaced on twelve (12) inch centers maximum or lead caulking rope. When lead strips are used for continuous caulked reglets, use approved weather-resistant fibrous compounds.

L. Scupper: Continuously support scupper, set to correct elevation, and seam frames to interior wall face, over cants or tapered edge strips, and under roofing membrane.

END OF SECTION

SECTION 077100

ROOF SPECIALTIES AND ACCESSORIES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the roof specialties and accessories as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Aluminum copings.

2. Roof hatches.

3. Roof smoke vents.

4. Prefabricated roof curbs.

1.3 RELATED SECTIONS

A. Roofing - Section 075419.

B. Sheet Metal Flashing - Section 076200.

1.4 SUBMITTALS

A. Before any roof specialties and accessories are delivered to the job site, submit shop drawings showing profiles and anchoring devices.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 ALUMINUM COPINGS

A. Fabricate of 0.063" thick aluminum alloy 5005-H154, smooth, no pattern.

B. Provide concealed splice plates 12'-0" o.c. fabricated of 0.050" thick aluminum to match exposed aluminum; finished to match exposed aluminum.

C. Provide pre-fabricated mitered and welded corner units.

D. Provide galvanized steel anchor plates, anchors spaced 6'-0" o.c. and snap-lock coping design; all anchors concealed.

E. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-chromate-fluoride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.

1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

2. Custom color and gloss as selected by the Architect.

F. Provide units manufactured by Hickman, or equal made by Cheney, Johns Manville or approved equal.

G. Membrane under copings shall be high temperature membrane as specified in 074113.

2.2 ROOF HATCH

A. Provide roof hatches as manufactured by Bilco, or approved equal, thermally broken mill finish aluminum roof hatch units of sizes shown on drawings, with 3" of rigid insulation at curbs and door and standard self-lifting mechanism. Provide manufacturer's standard hardware, including hold-open device, hinges, latch and operating handles for inside operation. Construct units for 40 lbs. per sq. ft. live load.

B. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation.

1. Height: 42 inches above finished roof deck.

2. Test load per code requirements.

3. Provide self-latching gate fabricated of same materials as safety railing system.

C. Davit System: Type selected by the Architect.

2.3 SMOKE VENTS

A. Provide shop primed galvanized steel heat and smoke vent units of sizes shown on drawings, with 1" rigid insulation at curbs and door, standard lifting mechanism and automatic heat and smoke sensitive release devices. Provide manufacturer's standard hardware including hold-open device, hinges, latch and operating handles for inside and outside operation.

B. Provide units manufactured by Bilco, Babcock-Davis, Milcor or approved equal.

2.4 PRE-FABRICATED ROOF CURBS

A. Provide manufacturer's standard shop fabricated units made of 14 ga. zinc coated steel factory primed with rust inhibitive primer, and insulated with 1-1/2" thick fiberglass board. Provide units manufactured by Pate, Louvers & Dampers, Inc., Industrial Louvers, Inc., or approved equal.

B. Reinforce units over 8'-0" long and units requiring reinforcement due to heavy loads by forming units of double-walled box-type construction with stiffeners of heavy gauge with flanges as required to provide sufficient rigidity and strength to withstand max. lateral forces in addition to super imposed vertical loads.

C. Sloping Roof Decks: For deck slopes of 1" per ft. and more, fabricate curb units (except expansion joint curbs) to form a level top edge. Where slope is less than 1" per ft., and curb is used to support equipment

with moving parts, or supports vertical elements such as gravity ventilators which are intended to be plumb, provide tapered wood nailers (treated wood) at top of curb units to form a level top edge.

D. Provide treated wood nailer, not less than 1-5/8" thick and of the width shown, but not less than the width of the curb wall assembly. Anchor nailer securely to the top of the metal frame unit. Refer to Section 062000 of these specifications for pressure-treatment required for wood nailers.

E. Provide 22 ga. galvanized steel curb liners; where required extend curb liners through deck construction to coordinate with work below.

F. Provide 18 ga. galvanized steel cap flashing to cover a min. of 3" over roof flashing.

G. Where curb units are shown to support shop fabricated items of equipment, do not proceed with fabrication of curb units until size or dimensions have been checked for coordination with equipment.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where roof specialties and accessories are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. General: Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, and with roof insulation, roofing and flashing; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

B. Isolation: Where metal surfaces of units are to be installed in contact with non-compatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.

C. Cap Flashing: Where cap flashing is required as component of accessory, install to provide adequate waterproof overlap with roofing or roof flashing (as counter flashing). Seal with thick bead of mastic sealant, except where overlap is indicated to be left open for ventilation.

D. Operational Units: Test operational units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces in accordance with manufacturer's instructions. Touch up damaged metal coatings.

END OF SECTION

SECTION 077600

ROOF PAVERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the roof pavers as shown on the drawings and/or specified herein, including but is not necessarily limited to the following:

1. Precast concrete pavers on adjustable pedestals or shims.

1.3 SUBMITTALS

A. Product Data: For each type of roof paver and accessory indicated.

B. Shop Drawings: After field verifying dimensions provide shop drawings showing layout of pavers and installation details for roof pavers. Show locations of roof drains, roof pitches, walls, parapets, roof penetrations, equipment and equipment supports.

C. Samples: For each type of paver finish required and for each type of paver accessory indicated. Provide full-size samples of pavers to adequately show color.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain each color, type, and variety of paver from a single source with resources necessary to provide products and materials of consistent quality in appearance and physical properties without delaying progress of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pavers during storage and construction against wetting by rain, snow, or ground water, and against staining or contamination from earth and other materials.

1.6 EXTRA STOCK

A. Upon completion of this portion of the Work, deliver to the Owner an extra stock of pavers, pedestals, and accessories of ten percent of each product and finish. All extra stock shall be new, in original packaging, and clearly labeled.

PART 2 PRODUCTS

2.1 PAVERS

A. Provide "Large Scale CalArc Pedestal Set Pavers" by Stepstone, Inc., or equal by Hanover Architectural Products, Concrete Collaborative, or approved equal.

1. Material: 5,000 psi hardrock concrete, Type III cement.
2. Color: Granada White #1401.
3. Finish: Exposed aggregate (to match landscape pavers).
4. Size: As indicated, 2-1/2" thick.
5. Pavers shall be reinforced with zinc plated welded wire mesh.

2.2 PAVER PEDESTALS

A. Provide support pedestals for pavers as recommended by paver manufacturer in sizes as required to support specified pavers at elevations shown on Drawings.

B. Combination of the following systems to achieve required paver height:

1. Rated for 1,000 lbs per pedestal. Impervious to water; mold and freeze/thaw.
2. High-Tab Pedestals: 7" across flats, 5/8" thick, 1/8" spacers. For pedestal heights up to 3".
3. Flexible Leveling Shims: 7" across flats. 1/16" or 1/8" thick. For final adjustments.
4. Compensator Leveling System: 7-3/4" diameter, 1/2" thick. For compensation of roof slope.
5. Elevator System - Base and Top. For pedestal heights over 3".
6. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
7. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

PART 3 EXECUTION

3.1 LAYOUT

A. Lay out roof pavers so as not to obstruct drainage paths or drains.

B. Start paver layout at center of roof sections in such a way as to avoid pavers of less than one-half width at edges or other joints with vertical obstructions.

3.2 COORDINATION

A. Coordinate paver installation with planter support structure.

B. Coordinate paver installation with radiant heating system by electrical contractor.

3.3 INSTALLATION

A. General: Install roof pavers according to manufacturer's written instructions. Use shims, separators, and other miscellaneous items as required for completing roof paver installation. Install roof pavers to resist exposure to weather without failing, shifting, and pedestal disengagement.

B. Install roof pavers without damaging or disturbing the roof membrane, maintaining watertight performance.

C. Install roof pavers without obstructing drainage paths or drains.

D. Cut pavers with a concrete saw cleanly, allowing for close fitting with walls, parapets, roof penetrations, and roof equipment and equipment supports. Pavers with chips in the exposed surface, over-sawn cuts, and irregular cuts are not permitted.

E. Install roof pavers level and true to line and elevation, and without warping or jogs in alignment. Install each paver securely so that it does not wobble or move in place.

F. Tolerances

1. Maximum of 1/16" height variation between adjacent pavers.

2. Individual pavers shall not vary more than 1/16" from level across width of the paver.

3. Paved areas shall not vary more than 1/8" from level in a distance of 10'-0" measured at any location and in any direction.

4. Joints between pavers shall be 1/8".

END OF SECTION

SECTION 078413

FIRESTOPS AND SMOKESEALS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the firestops and smokeseals as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Penetrations through fire-resistance-rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.

2. Penetrations through fire-resistance-rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.

3. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.

4. Sealant joints in fire-resistance-rated construction.

5. Penetrations at each floor level in shafts and/or stairwells.

6. Construction joints, including those between top of fire rated walls and underside of floors above; and those between exterior curtain walls and the outer perimeter edge of floor assemblies.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Unit Masonry - Section 042000.

C. Joint Sealers - Section 079200.

D. Glazed Aluminum Curtain Wall - Section 084413.

E. Gypsum Drywall - Section 092900.

F. Piping penetrations - Division 22.

G. Duct penetrations - Division 23.

H. Cable and conduit penetrations - Division 26.

1.4 REFERENCES

A. ASTM E 814 "Standard Method of Fire Tests of Through-Penetration Firestops."

B. UL 1479, UBC 7-5 (Both are same as A. above).

C. ASTM E 119 "Standard Method of Fire Tests of Building Construction and Materials."

D. UL 263, UBC 7-1 (Both are same as C. above).

E. UL 2079 "Tests For Fire Resistance of Building Joint Systems."

F. ASTM E 1399 "Test For Dynamic Movement Conditions."

G. ASTM E 1966 (Same as E. above).

H. ASTM G 21 "Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi."

I. Test Requirements: ASTM E 2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus."

J. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Firestops."

K. Published Through-Penetration Systems by recognized independent testing agencies.

1. UL Fire Resistance Directory, Volume II of current year.

2. Warnock Hersey Certification Listings, current year.

3. Omega Point Laboratories, current year.

L. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.

1.5 SUBMITTALS

A. Submit manufacturer's product literature for each type of firestop material to be installed. Literature shall indicate product characteristics, typical uses, performance, limitation criteria, test data and indication that products comply with specified requirements.

B. Submit shop drawings detailing materials, installation methods, and relationships to adjoining construction for each firestop system, and each kind of construction condition penetrated and kind of penetrating item. Include firestop design designation of qualified testing and inspection agency evidencing compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, for proposed UL listed (or equal) firestop and smokeseal assembly required for the Project.

C. Material Safety Data Sheets: Submit MSDS for each firestop product.

D. Submit qualifications of firestop installer, including letter from firestop manufacturer of products proposed to be installed, wherein manufacturer approves or recognizes as trained/ or certifies installer for installation of that manufacturer's products.

E. Engineering Judgment: For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set forth by the International Firestop Council.

1.6 QUALITY ASSURANCE

A. General: Provide firestopping systems that are produced and installed to resist the spread of fire and the passage of smoke and other gases.

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.

C. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings as required by local building code and as tested by nationally accepted test agencies per ASTM E 814 or UL 1479. The F-rating must be a minimum of one (1) hour, but not less than the fire resistance rating of the assembly being penetrated. T-rating, when required by code authority, shall be based on measurement of the temperature rise on the penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.

1. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

a. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
b. T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
c. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

2. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

a. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

D. Firestopping products shall be asbestos free and free of any PCBs.

E. Do not use any product containing solvents or that requires hazardous waste disposal.

F. Do not use firestop products which after curing, dissolve in water.

G. Do not use firestop products that contain ceramic fibers.

H. Firestopping Installer Qualifications: Firestop application shall be performed by a single firestopping contractor who specializes in the installation of firestop systems, whose personnel to be utilized have received specific training and certification or approval from the proposed respective firestop manufacturer, and firestop installer shall have a minimum of three years' experience (under present company name) installing firestop systems of the type herein specified.

I. Mock-Up: Prepare job site mock-ups of each typical Firestop System proposed for use in the project. Approved mock-ups will be left in place as part of the finished project and will constitute the quality standard for the remaining work.

J. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.

2. For floor penetrations with annular spaces exceeding 4 inches or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floor loads involved either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

K. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of less than or equal to 1 as determined by ASTM G 21.

L. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post-installed." Provide cast-in-place firestop devices prior to concrete placement.

M. Firestop systems do not reestablish the structural integrity of load bearing partitions or assemblies, or support live loads and traffic. Installer shall consult the Structural Engineer prior to penetrating any load bearing assembly.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original unopened containers with manufacturer's name, product identification, lot numbers, UL or Warnock Hersey labels, and mixing and installation instructions, as applicable.

B. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturer.

C. All firestop materials shall be installed prior to expiration of shelf life.

1.8 PROJECT CONDITIONS

A. Verify existing conditions and substrates before starting work

B. Do not use materials that contain solvents, show sign of damage or are beyond their shelf life.

C. During installation, provide masking and drop cloths as needed to prevent firestopping products from contaminating any adjacent surfaces.

D. Conform to ventilation requirements if required by manufacturer's installation instructions or Material Safety Data Sheet.

E. Weather Conditions: Do not proceed with installation of firestop products when temperatures are in excess or below the manufacturer's recommendations.

F. Schedule installation of firestop products after completion of penetrating item installation but prior to covering or concealing of openings.

G. Coordinate this work as required with work of other trades.

1.9 SEQUENCING AND SCHEDULING

A. Pre-Installation Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

B. Sequence: Perform work of this and other sections in proper sequence to prevent damage to the firestop systems and to ensure that their installation will occur prior to enclosing or concealing work.

C. Install all firestop systems after voids and joints are prepared sufficiently to accept the applicable firestop system.

D. Do not cover firestop systems until they have been properly inspected and accepted by the authority having jurisdiction.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following manufacturers:

1. Hilti, Inc.
2. Metacaulk.
3. Nelson.
4. Specified Technologies Inc.
5. 3M.
6. Tremco.
7. U.S. Gypsum Co.

2.2 FIRESTOPPING, GENERAL

A. Compatibility: Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.

B. Accessories: Provide components for each firestopping system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Accessories include but are not limited to the following items:

1. Permanent forming/damming/backing materials including the following:
    a. Semi-refractory fiber (mineral wool) insulation.
    b. Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Joint fillers for joint sealants.
2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

C. Applications: Provide firestopping systems composed of materials specified in this Section that comply with system performance and other requirements.

D. Smokeseals at top of partitions shall be flexible to allow for partition deflection.

E. Polypropylene Sleeves (PP): (For cast-in device options.)

2.3 FILL MATERIALS FOR THROUGH-PENETRATION FIRESTOP SYSTEMS

A. Endothermic, Latex Compound Sealant: Single-component, endothermic, latex formulation.

B. Intumescent, Latex Sealant: Single-component, Intumescent, latex formulation.

C. Intumescent Putty: Non-hardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.

D. Intumescent Wrap Strips: Single-component, elastomeric sheet with aluminum or polyethylene foil on one side.

E. Job-Mixed Vinyl Compound: Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero per ASTM E 84.

F. Mortar: Prepackaged dry mix composed of a blend of inorganic binders, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

G. Pillows/Bags: Re-usable, heat-expanding pillows/bags composed of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

H. Silicone Foam: Two-component, silicone-based liquid elastomer that, when mixed, expands and cures in place to produce a flexible, non-shrinking foam.

I. Silicone Sealant: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealant of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and non-sag formulation for openings in vertical and other surfaces requiring a non-slumping/gunnable sealant, unless firestop system limits use to non-sag grade for both opening conditions.

J. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic or polypropylene sleeve lined with an intumescent strip, an extended rectangular flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

K. Fire Rated Cable Management Devices: Factory-assembled round metallic sleeve device for use with cable penetrations, containing an integrated smoke seal fabric membrane that can be opened and closed for re-penetration.

L. Drop-In Firestop Devices: Factory-assembled devices for use with combustible or noncombustible penetrants in cored holes within concrete floors. Device shall consist of galvanized steel sleeve lined with an intumescent strip, an extended rectangular flange attached to one end of the sleeve for fastening to concrete floor, and neoprene gasket.

M. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

N. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

O. Blocks/Plugs: Intumescent flexible block/plug suitable for reuse in re-penetration of openings. Blocks shall allow up to 12" of unreinforced annular space.

P. Tub Box Kit: Cast-in place pre-formed plastic tub box kit with three support legs for use with drain piping assembly associated with bathtub installations.

2.4 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated that complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.

1. Sealant Colors: Color of exposed joint sealants as selected by the Architect.

B. Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.

1. Additional Movement Capability: Provide sealant with the capability to withstand 33 percent movement in both extension and compression for a total of 66 percent movement.

C. Multi-Component, Non-Sag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O.

1. Additional Movement Capability: Provide sealant with the capability to withstand 40 percent movement in extension and 25 percent in compression for a total of 65 percent movement in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated.

D. Single-Component, Non-Sag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.

2.5 MINERAL FIBER/CERAMIC WOOL NON-COMBUSTIBLE INSULATION (FIRE SAFING)

A. Provide min. 4 pcf Thermafiber as manufactured by Thermafiber Co., min. 4 pcf FBX Safing Insulation as manufactured by Fibrex, or approved equal to suit conditions and to comply with fire resistance and firestop manufacturer's requirements.

B. Material shall be classified non-combustible per ASTM E 119.

2.6 MIXING

A. For those products requiring mixing prior to application, comply with firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer present, for compliance with requirements for opening configuration, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements:

1. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.

2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form release agents from concrete.

B. Priming: Prime substrates where recommended by firestopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing seal of firestopping with substrates.

3.3 CONDITIONS REQUIRING FIRESTOPPING

A. Building Exterior Perimeters

1. Where exterior facing construction is continuous past a structural floor, and a space (i.e. construction joint) would otherwise remain open between the inner face of the wall construction and the outer perimeter edge of the structural floor, provide firestopping to equal the fire resistance of the floor assembly.

a. If mineral wool is part of firestop system, the mineral wool must be completely covered by appropriate thickness of UL or Warnock Hersey listed firestop sealant or spray.
b. Refer to Article 3.6 herein for description of fire safing insulation.

2. Firestopping shall be provided whether or not there are any clips, angles, plates, or other members bridging or interconnecting the facing and floor systems, and whether or not such items are continuous.

3. Where an exterior wall passes a perimeter structural member, such as a girder, beam, or spandrel, and the finish on the interior wall face does not continue up to close with the underside of the structural floor above, thus interrupting the fire-resistive integrity of the wall system, and a space would otherwise remain open between the interior face of the wall and the structural member, provide firestopping to continuously fill such open space.

B. Interior Walls and Partitions

1. Construction joints between top of fire rated walls and underside of floors above, shall be firestopped.

2. Firestop system installed shall have been tested by either UL or Omega Point, including exposure to hose stream test and including for use with steel fluted deck floor assemblies.

3. Firestop system used shall allow for deflection of floor above.

C. Penetrations

1. Penetrations include conduit, cable, wire, pipe, duct, or other elements which pass through one or both outer surfaces of a fire rated floor, wall, or partition.

2. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide firestopping to fill such spaces in accordance with ASTM E 814.

3. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, firestop annular space, if any, between sleeve and wall of opening.

D. Provide firestopping to fill miscellaneous voids and openings in fire rated construction in a manner essentially the same as specified herein before.

3.4 INSTALLING THROUGH PENETRATION FIRESTOPS

A. General: Comply with the through penetrations firestop manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for through penetration firestop systems by proven techniques to produce the following results:

1. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.5 INSTALLING FIRE RESISTIVE JOINT SEALANTS

A. General: Comply with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install joint fillers to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability and develop fire resistance rating required.

C. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross sectional shapes and depths relative to joint width that optimum sealant movement capability. Install sealants at the same time joint fillers are installed.

D. Tool no sag sealants immediately after sealant application and prior to the time skinning or curing begins. Form smooth, uniform beads of configuration indicated or required to produce fire resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.6 INSTALLING FIRESAFING INSULATION

A. Install fire safing insulation utilizing welded or screw applied galvanized steel impaling pins and retaining clips; space clips or pins 24" o.c. maximum.

B. Completely fill voids in areas where safing insulation is required. At spandrel conditions/floor edges, depth of insulation top to bottom shall be at least four (4) inches.

C. Cover top of all safing insulation with firestop sealant or spray.

3.7 FIELD QUALITY CONTROL

A. Inspecting agency employed and paid by the Owner will examine completed firestopping to determine, in general, if it is being installed in compliance with requirements.

B. Inspecting agency will report observations promptly and in writing to Contractor, Owner and Architect.

C. Do not proceed to enclose firestopping with other construction until reports of examinations are issued.

D. Where deficiencies are found, Contractor must repair or replace firestopping so that it complies with requirements.

3.8 CLEANING

A. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which openings and joints occur.

B. Protect firestopping during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestopping immediately and install new materials to product firestopping complying with specified requirements.

END OF SECTION

SECTION 079200

JOINT SEALERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the joint sealers work as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Flashing reglets and retainers.
2. Coping joints.
3. Exterior wall joints not specified to be sealed in other Sections of work.
4. Interior wall joints not specified to be sealed in other Sections of work, including caulking to fill between architectural woodwork and any wall, floor and/or ceiling imperfections.
5. Control and expansion joints in walls.
6. Joints at wall penetrations.
7. Joints between items of equipment and other construction.
8. All other joints required to be sealed to provide a positive barrier against penetration of air and moisture.

1.3 RELATED SECTIONS

A. Exterior Stone Cladding - Section 044200.

B. Roofing - Division 7.

C. Firestop sealants - Section 078413.

D. Sealant at metal-to-metal components of curtain wall - Section 084413.

E. Glazing sealants - Section 088000.

F. Sealant within drywall construction - Section 092900.

G. Sealant at tile work - Section 093013.

H. Sealant at paving - Division 32.

1.4 QUALITY ASSURANCE

A. Qualification of Installers: Use only personnel who are thoroughly familiar, skilled and specially trained in the techniques of sealant work, and who are completely familiar with the published recommendations of the sealant manufacturer.

B. Pre-Construction Field Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to project joint substrates according to the method in ASTM C 794 and C 1521 that is appropriate for the types of Project joints.

C. Perform testing per ASTM C 1248 on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces. No sealant work shall start until results of these tests have been submitted to the Architect and he has given his written approval to proceed with the work.

1.5 SUBMITTALS

A. Shop Drawings: Submit shop drawings showing all joint conditions, indicating relation of adjacent materials, all sealant materials (sealant, bond breakers, backing, primers, etc.), and method of installation.

1. Submit joint sizing calculations certifying that movement capability of sealant is not being exceeded.

B. Samples: Submit the following:

1. Color samples of sealants, submit physical samples (not color chart).

2. Sealant bond breaker and joint backing.

C. Product Data: Submit manufacturer's technical information and installation instructions for:

1. Sealant materials, indicating that material meets standards specified herein.

2. Backing rods.

D. Submit manufacturer's certification as required by Article 1.6 herein.

E. Submit results of testing required in Article 1.4 herein.

1.6 MANUFACTURER'S RESPONSIBILITY AND CERTIFICATION

A. Contractor shall require sealant manufacturer to review the Project joint conditions and details for this Section of the work. Contractor shall submit to the Architect written certification from the sealant manufacturer that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vaportight seals (as applicable), and that materials supplied meet specified performance requirements.

1.7 ENVIRONMENTAL CONDITIONS

A. Temperature: Install all work of this Section when air temperature is above forty (40) degrees F. and below eighty (80) degrees F., unless manufacturer submits written instructions permitting sealant use outside of this temperature range.

B. Moisture: Do not apply work of this Section on surfaces which are wet, damp, or have frost.

1.8 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section, before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

C. Storage

1. Store sealant materials and equipment under conditions recommended by their manufacturer.

2. Do not use materials stored for a period of time exceeding the maximum recommended shelf life of the material.

3. Material shall be stored in unopened containers with manufacturers' name, batch number and date when shelf life expires.

1.9 WARRANTY

A. Provide a written, notarized warranty from the manufacturer stating that the applied sealants shall show no material failure for a period of ten (10) years.

B. Contractor to provide a written, notarized warranty stating that the applied sealants shall show no failure due to improper installation for a period of five (5) years.

C. Warranty shall be in a form acceptable to the Owner and executed by an authorized individual.

D. Include in warranty provision an agreement to repair and/or replace, at the Contractor's expense, sealant defects that develop during the warranty period as a result of faulty labor and/or materials.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

A. Exterior Wall Sealant: Provide one (1) part non-sag sealant equal to No. 790 or 795 made by DowSil, "Silpruf SCS 2000" or "LM SCS 2700" made by G.E., "Spectrem 1" or "Spectrem 3" made by Tremco or "Sonolastic 150" by Sonneborn conforming to the minimum standards of ASTM C 920, Type S, Grade NS, Class 50.

B. Interior Sealant: Provide a one (1) part acrylic based sealant conforming to ASTM C 834, equal to "AC-20+ Silicone" made by Pecora, Masterseal NP 520 by BASF or equal made by Tremco.

C. Colors: Colors selected from manufacturer's standard selection.

2.2 MISCELLANEOUS MATERIALS

A. Back-Up Materials: Provide back-up materials and preformed joint fillers, non-staining, non-absorbent, compatible with sealant and primer, and of a resilient nature, closed-cell polyethylene foam equal to "HBR" made by Nomaco Inc. or approved equal, twenty-five (25) percent wider than joint width. Materials impregnated with oil, bitumen or similar materials shall not be used. Provide back-up materials only as recommended by sealant manufacturer in writing.

B. Provide bond breakers, where required, of polyethylene tape as recommended by manufacturer of sealant.

C. Provide primers recommended by the sealant manufacturer for each material to receive sealant. Note that each exterior joint must be primed prior to sealing.

D. Provide solvent, cleaning agents and other accessory materials as recommended by the sealant manufacturer.

E. Materials shall be delivered to the job in sealed containers with manufacturer's original labels attached. Materials shall be used per manufacturer's printed instructions.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where joint sealers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with instructions and recommendations of the manufacturer and in accordance with ASTM C 1193 for use of joint sealants as applicable to materials, applications and conditions required by this Project where more stringent installation requirements are specified herein, such requirements shall apply.

B. Sample Section of Sealant

1. During sealant installation work in exterior wall, the manufacturer of sealant shall send his representative to the site, under whose supervision a section of the wall (used as "control section") shall be completed for purposes of determining performance characteristics of sealant in joints. Architect shall be informed of time and place of such installation of control section.

2. Control section shall be installed according to specification given herein and shall not be considered as acceptable until written acceptance is provided by the Architect.

3. Accepted control section shall be standard to which all other sealant work must conform.

C. Supervision: The Contractor shall submit to the Architect written certification from the sealant manufacturer that the applicators have been instructed in the proper application of their materials. The Contractor shall use only skilled and experienced workmen for installation of sealant.

D. Apply sealant under pressure with a hand or power actuated gun or other appropriate means. Gun shall have nozzle of proper size and provide sufficient pressure to completely fill joints as detailed. Neatly point or tool joint to provide the contour as indicated on the drawings.

E. Preparation and Application

1. Thoroughly clean all joints, removing all foreign matter such as dust, oil, grease, water, surface dirt and frost. Sealant must be applied to the base surface. Previously applied film must be entirely removed.

2. Stone, masonry and concrete surfaces to receive sealant shall be cleaned where necessary by grinding, water blast cleaning, mechanical abrading, or combination of these methods as required to provide a clean, sound base surface for sealant adhesion.

   a. Do not use any acid or other material which might stain surfaces.
   b. Remove laitance by grinding or mechanical abrading.
   c. Remove loose particles present or resulting from grinding, abrading, or blast cleaning by blowing out joints with compressed air, oil and water free, or vacuuming joints prior to application of primer or sealant.

3. Clean non-porous surfaces such as metal and glass chemically. Remove protective coatings on metallic surfaces by solvent that leaves no residue and is compatible with sealant. Use solvent and wipe dry with clean, dry lint free paper towels. Do not allow solvent to air dry without wiping. Clean joint areas protected with masking tape or strippable films as above after removal of tape film.

4. Do not seal joints until they are in compliance with drawings, or meet with the control section standard.

5. Joint Size and Sealant Size: Joints to receive sealant shall be at least 1/4" wide. In joint 1/4" to 3/8" wide, sealant shall be 1/4" deep. In joints wider than 3/8" and up to 1" wide, sealant depth shall be one half the joint width. For joints wider than 1", sealant depth shall be as recommended by the sealant manufacturer. Depth of joint is defined as distance from outside face of joint to closest point of the filler.

6. Primer: Thoroughly clean joints and apply primer to all surfaces that will receive sealant. Apply primer on clean, dry surfaces, and prior to installation of joint backing. Completely wet both inner faces of the joint with primer. Mask adjacent surfaces of joint with non-staining masking tape prior to priming. Apply primer with clean brush and only when temperature is above 45 deg. F.

7. Joint Backing: In joints where depth of joint exceeds required depth of sealant, install joint backing (after primer is dry) in joints to provide backing and proper joint shape for sealant. Proper shape for sealant is a very slight "hourglass" shape, with back and front face having slight concave curvature. Use special blunt T-shaped tool or roller to install joint backing to the proper and uniform depth required for the sealant. Joint backing shall be installed with approximately twenty-five (25) percent compressions. Do not stretch, twist, braid, puncture, or tear joint backing. Butt joint backing at intersections.

8. Bond Breaker: Install bond breaker smoothly over joint backing so that sealant adheres only to the sides of the joint and not backing.

9. Sealant Application: Apply sealant in accordance with the manufacturer's application manual and manufacturer's instructions, using hand guns or pressure equipment, on clean, dry, properly prepared substrates, completely filling joints to eliminate air pockets and voids. Mask adjacent surfaces of joint with non-staining masking tape. Force sealant into joint in front of the tip of the "caulking gun" (not pulled after it) and force sealant against sides to make uniform contact with sides of joint and to prevent entrapped air or pulling of sealant off of sides. Fill sealant space solid with sealant.

10. Tooling: Tool exposed joints to form smooth and uniform beds, with slightly concave surface conforming to joint configuration per Figure 5A in ASTM C 1193. Finished joints shall be straight, uniform, smooth and neatly finished. Remove masking tape immediately after tooling of sealant and before sealant face starts to "skin" over. Neatly remove any excess sealant from adjacent surfaces of joint, leaving the work in a neat, clean condition.

11. Replace sealant which is damaged during construction process.

END OF SECTION

SECTION 079201

EXTERIOR JOINT SEALANTS - SITEWORK

PART 1 — GENERAL

1.1 SUMMARY

A. Caulk and seal joints as indicated on the on the submitted shop drawing location plan and as specified. Included, but do not limit to:
   1. Sealing of joints in exterior concrete and masonry construction; wet and dry conditions.
   2. All other exterior sealing called for, or reasonably inferred from the Drawings, and as required to provide weathertight conditions in exterior assemblies.

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
   1. Section 044302, MONOLITHIC STONE SITEWORK.
   2. Section 321313, LANDSCAPE CONCRETE.

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

   1. American Association of State Highway and Transportation Officials (AASHTO):

      M 220 Preformed Elastomeric Compression Joint Seals for Concrete

   2. American Society for Testing and Materials (ASTM):

      C 719 Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement

      C 790 Use of Latex Sealing Compounds

      C 834 Latex Sealing Compounds

      C 920 Elastomeric Joint Sealants

      C 962 Use of Elastomeric Joint Sealants

      C 1330 Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants

      D 412 Test Methods for Rubber Properties in Tension

      D 624 Test Method for Rubber Property - Tear Resistance

      D 2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

   3. Federal Specifications (Fed. Spec.):

TT-S-00227 Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

TT-S-001543A Sealing Compound: Silicone Rubber Base (For Calking, Sealing, and Glazing in Buildings and Other Structures)

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each sealant material used. Provide certifications that sealant materials comply with specified requirements.

B. Initial Selection Samples: Submit samples manufacturer's color charts showing complete range of colors, textures, and finishes available for each material used.

C. Verification Samples: Submit actual representative samples of each sealant material that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide sealant samples having minimum size of 4 in. long.

D. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.

E. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

F. Test Reports: Provide certified reports for all specified tests.

1.5 COMPATIBILITY

A. Provide sealant and sealant joint backing materials suitable for the use intended and compatible with the materials with which they will be in contact. Compatibility of sealant and accessories shall be verified by the sealant manufacturer.

1.6 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

B. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of the Work.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.

2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

C. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.

2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of nonelastomeric sealant and joint substrate indicated.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.

4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
   c. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.

      (a) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

D. Provide testing of joint sealant material at stone masonry joints to determine possibility of staining stone material. Test shall be conducted in accordance with ASTM C 1248. If test results indicate staining of stone materials as a result of joint sealant material, Contractor shall use primer at joints or take other measures as recommended by joint sealant manufacturer and testing agency to prevent such staining.

E. Mock-ups: Construct mock-ups incorporating sealant joints to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Obtain Landscape Architect's acceptance of visual qualities before commencement of further work.
1. Protect and maintain accepted mock-ups throughout the remainder of the work of this section to serve as criteria for acceptance of the work.

2. Joints in mock-ups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

F. Source: For each sealant material type required for the work of this section, provide primary materials which are the product of one manufacturer. Provide secondary or accessory materials which are acceptable to the manufacturers of the primary materials.

G. Installer: A firm with a minimum of five years' experience in type of work required by this Section and which is acceptable to the manufacturers of the primary materials.

1.7 PROJECT CONDITIONS

A. Weather: Perform work of this Section only when existing or forecasted weather conditions are within the limits established by manufacturers of the materials and products used.

B. Substrates: Proceed with work only when substrate construction and penetration work is complete.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Materials under this Section shall be delivered to, and stored at, the job site in unbroken factory sealed containers with labels intact.

1.9 WARRANTY

A. Furnish joint sealant manufacturer's written single-source performance warranty that joint sealant work will be free of defects related to workmanship or material deficiency for five years from date of Substantial Completion of the Project.

PART 2 — PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Before installation check each sealant for compatibility with adjacent materials and surfaces and with indicated exposures. Select sealers which are recommended by manufacturer for each application indicated. Where exposed to pedestrian or vehicular traffic, provide sealants which are non-tracking and are strong enough to withstand the traffic without damage.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

1. Primer: If testing of sealant used at stone masonry joints produces staining at joint then Contractor shall, at direction of testing agency, provide primer at joint as approved by sealant manufacturer.

C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247

and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

2.4 HIGH PERFORMANCE SILICONE SEALANT – ALL SITE GRANITE

A. Sealant For Joints Between Granite Pieces, Whether Below Water or Above Water: shall be Dow Corning 795, a one-part, cold-applied, non-sagging silicone material that cures to a medium modulus silicone rubber upon exposure to atmospheric moisture, manufactured by Dow Corning Corporation Corporate Center 2200 W. Salzburg Rd. PO Box 994 Auburn MI 48611; Direct Dial: 989-496-7875; Toll Free: 1-800-248-2481, or approved equal.

1. Sealant shall be non-staining.
2. Color: As selected by Landscape Architect from manufacturers full line of not less than 10 colors.

B. Extent: Provide high performance silicone sealant for joints at all granite masonry work.

2.5 NON-SAG POLYURETHANE SEALANT

A. Provide multi-part, non-sag, polyurethane based elastomeric sealant, complying with ASTM C 920 Type M, Grade NS, Class 25, Fed. Spec. TT-S-00227E Class A, having Shore A hardness of 20 to 30, cured modulus of elasticity at 100% elongation of not more than 75 psi, and tear resistance of not less than 50 lbs./inch when tested according to ASTM D 624.

B. Provide one of the following products that meet or exceed specified requirements:

1. Mameco International Vulkem 227
2. Harry S. Peterson Co. Iso-Flex 2000
3. Sika Sikaflex 2c NS.
4. Sonneborn Sonolastic NP 2.
5. Tremco Dymeric

C. Where joint requires 50% movement capabilities, provide Tremco Dymeric Plus, or equal product approved by Landscape Architect.

D. Extent: Provide non-sag polyurethane sealant for all paving joints, and other joints not indicated to be sealed with another type of sealant.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Provide primer recommended by sealant manufacturer for surfaces to be adhered to.

B. Bond Breaker Tape: Provide polyethylene or other plastic tape recommended by sealant manufacturer to prevent three-sided adhesion.

C. Backer Rod: Provide closed cell compressible rod of durable nonabsorptive material recommended by sealant manufacturer for compatibility with sealant, conforming to ASTM C 1330. Provide products of one of the following manufacturers:

1. Backer Rod Manufacturing and Supply Co.
2. Dow Chemical Co.
3. W. R. Meadows, Inc.
4. Williams Products, Inc.
5. Woodmont Products, Inc.

D. Joint backing for general use at joints in horizontal surfaces shall consist of two rows of butyl rubber or neoprene foam rod in contact with one another, and each compressed to approximately 2/3 original width when in place.

E. Provide miscellaneous materials of type that will not bleed through sealant, discolor surface, or produce other deleterious effects. Select size to provide compression to approximately 2/3 original width when in place. Provide backing material profile concave to the rear of the sealant, and equipped with a bond-breaking film.

PART 3 — EXECUTION

3.1 INSPECTION

A. The Installer shall examine substrates and conditions under which this work is to be performed and notify Contractor, in writing, of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning of sealant work means Installer's acceptance of joint surfaces and conditions.

3.2 PREPARATION

A. Strictly comply with manufacturers' instructions and recommendations, except where more restrictive requirements are specified in this Section.

B. Clean joint surfaces immediately before installation of sealants, primers, tapes and fillers. Remove substances which could interfere with bond. Etch or roughen joint surfaces to improve bond. Surfaces which have been given protective coatings and those that contain oil or grease shall be thoroughly cleaned with xylol or MEK solvent, with due precautions taken to minimize hazards.

C. Unless otherwise indicated, use of sealants shall conform to the following: ASTM C 790 for latex sealants and ASTM C 962 for other sealants.

D. Tape or mask adjoining surfaces to prevent spillage and migration problems.

E. Prime surfaces as recommended by sealant manufacturer.

3.3 INSTALLATION

A. Schedule work as long as possible after completion of concrete work and finished brick paving and granite work.

B. Provide backer rods for liquid sealants except where specifically recommended against by sealant manufacturers.

C. Prevent three sided adhesion by use of bond breaker tapes or backer rods.

D. Force sealant into joints to provide uniform, dense, continuous ribbons free from gaps and air pockets. Completely wet both joint surfaces equally on opposite sides.

E. Except in hot weather, make sealant surface slightly concave. Install sealants so that compressed sealants do not protrude from joints. Dry tool sealants to form a smooth dense surface. At horizontal joints form a slight cove to prevent trapping water.

F. Provide sealants to depths indicated, or if not indicated, follow manufacturer's recommendations. For joints up to 3/8 in. width, depth of joint shall not exceed 1/2 in.; for joints larger than 1/2 in. width, depth of joint shall not exceed 5/8 in.

3.4 EXTENT OF SEALANT WORK

A. General Extent: Seal joints indicated, and all exterior joints, seams, and intersections between dissimilar materials. Provide elastomeric sealant installation with backer rod in all exterior control joints.

B. Exterior Sealing: Without limitation, the work of this Section includes sealing the following:

1. Masonry to masonry joints in dry conditions.
2. Masonry to masonry joints in wet conditions.
3. Masonry to other materials, including concrete.
4. Concrete to concrete joints.
5. Joints and cracks in paving and walks.
6. Joint fillers for all joints.

3.5 CURING

A. Cure sealants in strict compliance with manufacturers' instructions and recommendations to obtain highest quality surface and maximum adhesion. Make every effort to minimize accelerated aging effects and increase in modulus of elasticity.

3.6 CLEANING AND PROTECTION

A. Remove smears from adjacent surfaces immediately, as the work progresses. Exercise particular care to prevent smearing or staining of surrounding surfaces which will be exposed in the finished work, and repair any damage done to same as result of this work without additional cost to Owner.

B. Remove and replace work that is damaged or deteriorated.

C. Clean adjacent surfaces using materials and methods recommended by sealant manufacturer. Remove and replace work that cannot be successfully cleaned.

D. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protection immediately before final acceptance.

END OF SECTION

DIVISION 08
OPENINGS

SECTION 079500

EXPANSION CONTROL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the expansion joint covers as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Floor expansion joint cover assemblies.

2. Wall expansion joint cover assemblies.

3. Ceiling expansion joint cover assemblies.

4. Roof expansion joint cover assemblies.

5. Expansion joint covers between new and existing construction for walls, floors, ceilings.

6. Preformed foam sealant.

B. Fire rated expansion joint cover assemblies where required.

1.3 RELATED SECTIONS

A. Concrete - Section 033000.

B. Masonry work - Section 042000.

C. Roofing - Division 7.

D. Painting - Section 099000.

1.4 SUBMITTALS

A. Submit product data for each type of expansion joint cover assembly specified, including manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.

B. Submit shop drawings showing fabrication and installation of expansion joint cover assemblies, including plans, elevations, sections, details of components, joints, splices, and attachments to other units of work.

C. Submit samples for verification purposes in full size units of each type of expansion joint cover assembly indicated; within sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics. Install elastomeric material for joints, samples to verify color selected.

1.5 QUALITY ASSURANCE

A. Fire Test Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E 119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire Resistance Ratings: Rating as shown on drawings and Specifications.

B. Joint covers shall permit unrestrained movement of joint without disengagement of cover.

C. Provide a single source manufacture for all expansion joints in order to maintain manufacturer's warrantee for factory fabricated transitions for both cover and fire barrier.

D. Floor joint cover plate assemblies shall be capable of supporting a 200 psf uniform load and a 300 lb. concentrated load with a deflection not to exceed 1/16".

1.6 DELIVERY, STORAGE AND HANDLING

A. Provide temporary protective cover on finished surfaces.

B. Deliver joint covers to jobsite in new, clean, unopened crates of sufficient size and strength to protect materials during transit.

C. Store components in original containers in a clean, dry location.

D. Handle components with equipment of sufficient size to preclude hazard to personnel or components.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Profiles and details shown on drawings are those of Construction Specialties and Emseal unless otherwise noted; subject to compliance with requirements specified, other acceptable manufacturers include Balco/Metalines, MM Systems Corporation, Watson Bowman Acme or approved equal.

1. Surface-Mounted Wall and Ceiling Cover: ASM Series; ASM-SJPFM.

2.2 MATERIALS

A. Aluminum: ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 6061-T6, sheet and plate; aluminum to have the following finishes:

1. Interior and exterior walking surfaces shall have clear anodized (A41) finish.

2. Exterior surfaces not subject to pedestrian traffic shall have a "Kynar 500" finish conforming to NAAMM 605.2; two (2) colors shall be required, one (1) color to match metal siding and the other color to match adjacent concrete surfaces.

3. Interior surfaces not subject to pedestrian traffic shall be shop primed with rust inhibitive primer, minimum 2 mils thick, ready to receive field painted finish.

B. Stainless Steel: ASTM A 666, Type 304, No. 4 finish.

C. Protect metal surfaces to be placed in contact with cementitious materials with a protective coating.

D. Extruded Preformed Seals: Single or multi-cellular elastomeric profiles as classified under ASTM D 2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color, as selected by Architect from manufacturer's standard colors.

E. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E 119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

1. Supply PyroFlex Fire Barrier Sealing System PF Series for Architectural Joints fire-resistive barrier systems that have ratings equal to or greater than the rating of adjacent construction when tested in accordance with the aforementioned standards. Provide specified [1, 2, 3 or 4] hour rated fire barrier expansion joint assembly for floors and/or specified [1, 2 or 3] hour rated fire barrier expansion joint assembly for walls.

F. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.3 EXPANSION JOINT COVER ASSEMBLIES

A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated on drawings. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Furnish units in longest practical lengths to minimize number of end joints. Provide hairline mitered corners where joint changes direction or abuts other materials. Include closure materials and transition pieces, tee-joints, corners, transition pieces, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.

1. Special conditions shall be shop fabricated.

2. Fabricate components in largest practical lengths to minimize field splicing.

B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated.

C. All shop drawings shall be signed and sealed by a third party engineering firm.

D. Fire Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated to provide fire-resistive rating not less than the rating of adjacent construction.

E. All transitions between vertical and horizontal joints shall be factory fabricated.

2.4 PREFORMED FOAM SEALANT

A. Preformed Foam Sealant: Preformed sealant shall be silicone pre-coated, preformed, pre-compressed, self-expanding, sealant system. Expanding foam to be cellular foam impregnated with a water-based, non-drying, 100% acrylic dispersion. Seal shall combine factory-applied, low-modulus silicone and a backing of acrylic-impregnated expanding foam into a unified hybrid sealant system.

1. Expandable Seal (EJ2): Provide "Seismic Colorseal-DS" as manufactured by Emseal Joint Systems Ltd. or approved equal, color as selected by the Architect. Provide silicone sealer fillers as required to insure waterproof seal.

PART 3 EXECUTION

3.1 PREPARATION

A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.2 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting into new and existing construction as required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement of thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3" from each end and not more than 24" o.c.

B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure sensitive tape as recommended by manufacturer.

C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.

D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.

E. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

3.3 CLEANING AND PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION

SECTION 081113

STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the steel door and frame work as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Interior and exterior hollow metal doors and frames for fire-rated and unrated door openings.

2. Interior hollow metal vision panels.

3. Preparation of metal doors and frames to receive finish hardware, including reinforcements, drilling and tapping, as necessary.

4. Preparation of hollow metal doors to receive glazing where required.

5. Steel louvers for hollow metal doors.

6. Furnishing anchors for building into drywall.

7. Factory prime painting of work of this Section.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000, for installation of doors and frames.

B. Wood Doors - Section 081416.

C. Finish Hardware - Section 087100.

D. Glass and Glazing - Section 088000.

E. Gypsum Drywall - Section 092900.

F. Painting and Finishing - Section 099000.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, compliance with standards referenced herein, sound and fire-resistance ratings, and finishes for each type of door and frame specified.

B. Shop Drawings: Show fabrication and installation of doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, reinforcement for surface applied hardware, dimensions of profiles and hardware preparation, location and installation requirements

of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessories.

C. Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.

1. Coordinate glazing frames and stops with glass and glazing requirements.

D. Oversize Construction Certification: For door assemblies required to be fire rated and exceeding limitations of labeled assemblies, submit certification of a testing agency acceptable to authorities having jurisdiction that each door and frame assembly has been constructed to comply with design, materials, and construction equivalent to requirements for labeled construction.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

C. Source Limitations: Obtain custom steel doors and frames through one source from a single manufacturer.

D. Fire-Rated Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.

1. Test Pressure: Test according to NFPA 252 or UL 10C. After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40" or less above the sill.

2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-protection-rated door assemblies except for size.

3. Temperature-Rise Rating: At exit enclosures, provide doors that have a temperature-rise rating as required by prevailing Building Code in 30 minutes of fire exposure.

4. Fire rated assemblies must have UL approved label.

E. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.

F. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

G. Work of this Section must meet the minimum standards of ANSI 250.4 and SDI-100; where more stringent requirements are specified herein, such requirements shall apply.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage. Do not use nonvented plastic.

B. Inspect doors and frames, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Architect; otherwise, remove and replace damaged items as directed.

C. Store doors and frames under cover at building site. Conform to the requirements of ANSI A 250-11-2001 for site storage unless more stringent requirements are noted herein. Place units on minimum 4-inch high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 PRODUCTS

2.1 FABRICATION - GENERAL

A. Fabricate hollow metal units to be rigid, neat in appearance and free from defects, warp or buckle. Accurately form metal to required sizes and profiles. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

B. Unless otherwise indicated, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

C. Prepare hollow metal units to receive finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with Finish Hardware Schedule and templates provided by hardware suppliers. Comply with applicable requirements of ANSI A115 "Specifications for Door and Frame Preparation for Hardware."

D. Locate finish hardware as shown on final shop drawings in accordance with locations noted herein.

2.2 MANUFACTURERS

A. Provide products manufactured by Steelcraft, Curries, Ceco Door Products, or approved equal meeting these specifications.

2.3 FRAMES

A. Materials

1. Frames for exterior openings shall be made of commercial grade cold-rolled steel conforming to ASTM A 1008, Type B not less than 14 ga., and shall have a hot dipped galvannealed coating conforming to ASTM A 924 and A 653 with A60 coating. The zinc-alloy coating shall be a dull matte surface treated for paint adhesion.

2. Frames for interior openings shall be either commercial grade cold-rolled steel conforming to ASTM A 1008, Type B or commercial grade hot-rolled steel conforming to ASTM A 1011, Commercial Steel, Type B. Metal thickness shall be not less than sixteen (16) ga. for frames in openings 4'-0" or less in width; not less than fourteen (14) ga. for frames in openings over 4'-0" in width.

B. Design and Construction

1. All frames shall be welded units with integral trim, of the sizes and shapes shown on approved shop drawings. Knock-down frames are not permitted.

2. All finished work shall be strong and rigid, neat in appearance, square, true and free of defects, warp or buckle. Molded members shall be clean cut, straight and of uniform profile throughout their lengths.

3. Jamb depths, trim, profile and backbends shall be as shown on drawings.

a. Frames at drywall partitions shall be formed with double return backbends to prevent cutting into drywall surface.

4. Welded frames shall have corners mitered and reinforced and faces of welded frames shall be continuously back welded full depth and width of frame conforming to NAAMM Standard HMMA-820; face joints shall be hairline.

5. Minimum depth of stops shall be 5/8".

6. Frames for multiple or special openings shall have mullion and/or rail members which are closed tubular shapes having no visible seams or joints. All joints between faces of abutting members shall be securely welded and finished smooth.

   a. Mullions shall have 16 ga. internal steel stiffeners welded not less than 4" o.c.

7. Hardware Reinforcements

   a. Frames shall be mortised, reinforced, drilled and tapped at the factory for fully-templated mortised hardware only, in accordance with approved hardware schedule and templates provided by the hardware supplier. Where surface-mounted hardware is to be applied, frames shall have reinforcing plates.
   b. Minimum thickness of hardware reinforcing plates shall be as follows:
      1). Hinge and pivot reinforcements - seven (7) ga., 1-1/4" x 10" minimum size.
      2). Strike reinforcements - twelve (12) gauge
      3). Flush bolt reinforcements - twelve (12) gauge
      4). Closer reinforcements - twelve (12) gauge
      5). Reinforcements for surface mounted hardware - twelve (12) gauge.

8. Floor Anchors

   a. Provide adjustable floor anchors, providing not less than two (2) inch height adjustment.
   b. Minimum thickness of floor anchors shall be fourteen (14) gauge.

9. Jamb Anchors: Frames for installation in stud partitions shall be provided with steel anchors of suitable design, not less than eighteen (18) gauge thickness, securely welded inside each jamb as follows:

   a. Frames up to 7'-6" height - four (4) anchors.
   b. Frames 7'-6" to 8'-0" height - five (5) anchors.
   c. Frames over 8'-0" height - five (5) anchors plus one additional for each 2'-0" or fraction thereof over 8'-0".

10. Anchors in exterior frames shall be hot dip galvanized per ASTM A 153.

11. Ceiling Struts: Minimum 3/8" thick x 2" wide steel.

12. All frames shall be provided with a steel spreader temporarily attached to the feet of both jambs to serve as a brace during shipping and handling.

13. Loose glazing stops shall be of cold rolled steel, not less than twenty (20) gauge thickness, butted at corner joints and secured to the frame with countersunk cadmium-or zinc-plated screws. Interior frames may be provided with snap-on glazing stops.

14. Except on weatherstripped frames, drill stops to receive three (3) silencers on strike jambs of single door frames and two (2) silencers on heads of double-door frames.

C. Finish: After fabrication, all tool marks and surface imperfections shall be removed, and exposed faces of all welded joints shall be dressed smooth. Frames shall then be chemically treated to insure maximum paint adhesion and shall be coated on all surfaces with one coat of rust-inhibitive baked-on alkyd primer standard with the manufacturer which is fully cured before shipment to a dry film thickness of 2.0 mils.

2.4 HOLLOW METAL DOORS

A. Materials: Doors shall be made of commercial quality, level, cold rolled steel conforming to ASTM A 1008, Commercial Steel, Type B and free of scale, pitting or other surface defects. Face sheets for interior doors shall be not less than eighteen (18) gauge. Face sheets for exterior doors shall be not less than sixteen (16) gauge and shall have a hot dipped galvannealed coating conforming to ASTM A 924 and A 653, A60 coating. The zinc alloy coating shall be a dull matte surface treated for paint adhesion.

B. Design and Construction

1. All doors shall be of the types and sizes shown on the approved shop drawings, and shall be fully welded seamless construction with no visible seams or joints on their faces or vertical edges. Minimum door thickness shall be 1-3/4".

2. All doors shall be strong, rigid and neat in appearance, free from warpage or buckles. Corner bends shall be true and straight and of minimum radius for the gauge of metal used.

3. Face sheets shall be stiffened by continuous vertical formed steel sections spanning the full thickness of the interior space between door faces. These stiffeners shall be not less than twenty-two (22) gauge spaced not more than six (6) inches apart and securely attached to face sheets by spot welds not more than five (5) inches o.c. Spaces between stiffeners shall be sound deadened and thermal insulated the full height of the door with an inorganic non-combustible batt type material.

4. Door faces shall be joined at their vertical edges by a continuous weld extending the full height of the door. All such welds shall be ground, filled and dressed smooth to make them invisible and provide a smooth flush surface.

5. Top and bottom edges of all doors shall be closed with a continuous recessed steel channel not less than fourteen (14) gauge, extending the full width of the door and spot welded to both faces. Exterior doors shall have an additional flush closing channel at their top edges and, where required for attachment of weatherstripping, a flush closure also at their bottom edges. Openings shall be provided in the bottom closure of exterior doors to permit the escape of entrapped moisture.

6. Edge profiles shall be provided on both vertical edges of doors as follows:

a. Single-Acting Swing Doors: Beveled 1/8" in two (2) inches.
b. Double-Acting Swing Doors: Rounded on 2-1/8" radius.
c. No square edge doors permitted.

7. Hardware Reinforcements

a. Doors shall be mortised, reinforced, drilled and tapped at the factory for fully templated hardware only in accord with the approved hardware schedule and templates provided by the hardware supplier. Where surface-mounted hardware (or hardware, the interrelation of which is to be adjusted upon installation - such as top and bottom pivots, floor closers, etc.) is to be applied, doors shall have reinforcing plates.
b. Minimum gauges for hardware reinforcing plates shall be as follows:
1). Hinge and pivot reinforcement - seven (7) gauge.
2). Reinforcement for lock face, flush bolts, concealed holders, concealed or surface mounted closers - twelve (12) gauge.
3). Reinforcements for all other surface mounted hardware - sixteen (16) gauge.

8. Glass Moldings and Stops

   a. Where specified or scheduled, doors shall be provided with hollow metal moldings to secure glazing by others in accordance with glass opening sizes shown on drawings.
   b. Fixed moldings shall be securely welded to the door on the security side.
   c. Loose stops shall be not less than twenty (20) gauge steel, with mitered corner joints, secured to the framed opening by cadmium or zinc-coated countersunk screws spaced eight (8) inches o.c. Snap-on attachments will not be permitted. Stops shall be flush with face of door.

9. Louvers shall be sixteen (16) gauge sheet steel, stationary type, closely spaced inverted "V" blade design, flush with face sheets of door, integral with and welded to door. Fifty (50) percent free area, unless indicated otherwise on drawings.

C. Finish: After fabrication, all tool marks and surface imperfections shall be dressed, filled and sanded as required to make all faces and vertical edges smooth, level and free of all irregularities. Doors shall then be chemically treated to insure maximum paint adhesion and shall be coated, on all exposed surfaces, with manufacturer's standard rust-inhibitive alkyd primer as specified for frames which shall be fully cured before shipment.

D. Flatness: Doors shall maintain a flatness tolerance of 1/16" maximum, in any direction, including in a diagonal direction.

2.5 LABELED DOORS AND FRAMES

A. Labeled doors and frames shall be provided for those openings requiring fire protection ratings as scheduled on drawings. Such doors and frames shall be labeled by Underwriters' Laboratories or other nationally recognized agency having a factory inspection service.

B. If any door or frame specified by the Architect to be fire-rated cannot qualify for appropriate labeling because of its design, size, hardware or any other reason, the Architect shall be so advised before fabricating work on that item is started.

2.6 HARDWARE LOCATIONS

A. The location of hardware on doors and frames shall be as noted in "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames" of the Door Hardware Institute unless otherwise required by prevailing Handicapped Codes.

2.7 CLEARANCES

A. Fabricate doors and frames to meet edge clearances as follows:

1. Jambs and Head: 1/8" plus or minus 1/16".

2. Meeting Edges, Pairs of Doors: 1/8" plus or minus 1/16".

3. Bottom: 3/8" at threshold; 3/4" if no threshold.

B. Fire-rated doors shall have clearances as required by NFPA 80.

2.8 MANUFACTURING TOLERANCES

A. Manufacturing tolerance shall be maintained within the limits given in HMMA 841 of ANSI/NAAMM, current edition.

2.9 PREPARATION FOR FINISH HARDWARE

A. Prepare door and frames to receive hardware:

1. Hardware supplier shall furnish hollow metal manufacturer approved hardware schedule, hardware templates, and samples of physical hardware where necessary to insure correct fitting and installation.

2. Preparation includes sinkages and cut-outs for mortise and concealed hardware.

B. Provide reinforcements for both concealed and surface applied hardware:

1. Drill and tap mortise reinforcements at factory, using templates.

2. Install reinforcements with concealed connections designed to develop full strength of reinforcements.

2.10 REJECTION

A. Hollow metal frames or doors which are defective, have hardware cutouts of improper size or location, or which prevent proper installation of doors, hardware or work of other trades, shall be removed and replaced with new at no cost.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where steel doors and frames are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Refer to Section 062000 for installation procedures for all work of this Section.

END OF SECTION

SECTION 081416

WOOD DOORS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the wood doors as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Solid core flush wood doors, including sliding doors.

2. Solid core raised panel wood doors.

3. Fire-rated flush wood doors.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000, for installation of wood doors.

B. Steel Doors and Frames - Section 081113, for hollow metal frames.

C. Finish Hardware - Section 087100.

D. Glass and Glazing - Section 088000.

E. Painting and Finishing - Section 099000, for field painting of wood doors.

1.4 SUBMITTALS

A. Product Data: Submit door manufacturer's product data, specifications and installation instructions for each type of wood door.

1. Include details of core and edge construction and trim for openings.

2. Include factory finish specifications.

3. Include certifications to show compliance with specifications.

4. Include certification to show compliance with AWI and WDMA requirements specified herein.

B. Shop Drawings: Submit shop drawings indicating location and size of each door, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for finishing and other pertinent data.

1. Include requirements for veneer matching.

C. Submit samples of factory finishes applied to actual door face materials, approximately 8 by 10 inches for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

B. Quality Standard: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated"; latest edition "Premium" grade and WDMA "Extra Heavy Duty" Performance Level.

1. Only manufacturers that are certified and listed by AWI to be QCP qualified are acceptable for this project.

2. Provide letter of licensing for Project indicating that doors comply with requirements of grade specified.

C. Fire-Rated Wood Doors: Doors complying with Category A, Positive Pressure or Neutral Pressure testing standards per UBC 7-2-1997 and UL 10C (UBC 7-2-1994 and UL 10B) that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated on Door Schedule, based on testing according to NFPA 252.

1. Conform to prevailing Code requirements to determine which pressure standard (Positive or Neutral) is required.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials or workmanship, have warped (bow, cup, or twist) in excess of permitted standard noted in Article 2.3 herein, or show telegraphing of core construction in face veneers.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

2. Warranty shall be in effect during the following period of time from date of Substantial Completion:

a. Solid Core Flush Wood Doors: Life of installation.
b. Stile and Rail Wood Doors: Five years.

PART 2 PRODUCTS

2.1 SOLID CORE FLUSH WOOD DOORS

A. Provide AWI PC-5 Premium Grade hot pressed 5-ply solid core particleboard doors, 1-3/4" thick, conforming to standards specified herein. Subject to meeting standards specified herein, the

following manufacturers are acceptable: Marshfield Door Systems, Inc., Algoma Hardwoods Inc., or Eggers Industries.

1. Core shall consist of a formed flat panel consisting of wood particles bonded together with synthetic resins or other added binder, with an average density of 30 to 32 lbs. per cubic foot. The material shall meet or exceed the requirements of ANSI A208.1, Grade 1-LD-2 covering mat formed particleboard with face screw holding of 124 lbs., modulus of rupture of minimum 700 psi and modulus of elasticity of not less than 148,000 psi.

2. Core shall be capable of satisfying this WDMA TM-7 cycle slam test for 1 million slams for surface mounted hardware. Where the manufacturer's core does not meet this criterion, stiles and rails must measure a minimum of 5-1/2" and must be fabricated of hardwood.

    a. Surface mounted hardware must be installed with minimum 1-1/4" screw penetrations using threaded to the head screws; coordinate with Section 087100.

B. Cross Bands: Shall be 1/16" thick hardwood extending full width of door and laid with grain at right angles to face veneers. Cross bands and faces shall be laminated to the core with Type I MF or PVA glue.

C. Stiles, Rails: Stile and rail shall be a minimum of 1-3/8" solid hardwood or structural composite lumber (after trimming) laminated to the core. Stiles and rails must be securely glued to the core with no voids allowed. Stiles and rails must be capable of screw holding of 550 lbs. per WDMA TM-10.

D. Transparent Finish: Finish in the shop with clear satin catalyzed polyurethane finish conforming to AWI System "Catalyzed Polyurethane Transparent."

1. Doors with transparent finish to have center balanced, slip matched, quarter sliced, Select veneer of wood species selected by the Architect. Veneer to conform to AWI, "AA" grade veneer with 3" wide leaf. Minimum veneer thickness shall be not less than 1/50" after sanding.

2. Veneers shall be continuous or end matched at transoms.

E. Opaque Finish: For doors to be field painted, shop prime on all surfaces with one coat of alkyd wood primer applied to a dry film thickness of 1.5 mils.

1. Doors to be field painted shall have MDO or hardboard face.

F. Where glass lites are noted, factory cut openings. Trim openings with solid hardwood moldings of same type of wood as face veneer. Lite openings in 20 minute rated doors shall have manufacturer's 20-minute approved hardwood system.

G. Doors shall have hinge-loading capacity of 500 lbs. per WDMA TM-8.

H. Vertical door edge must be capable of screw holding of 550 lbs. per WDMA TM-10; horizontal door edge must be capable of screw holding of 400 lbs. per WDMA TM-10.

I. Fire-Rated Wood Doors: Provide mineral core 1-3/4" thick solid core wood doors conforming to standards specified herein, manufactured by one of the manufacturers noted above. Stile construction on both stiles shall conform to the following:

1. Stile edge screw withdrawals when tested in accordance with ASTM D 1037-12 shall exceed 650 lbs. This applies to both stiles.

2. Stile edge split resistance when tested in accordance with ASTM D 143-14 Modified must exceed 950 lbs. This applies to both stiles.

3. Door to have face finish as specified above.

    a. Where the core is free of urea formaldehyde, provide a layer of veneer over the substrate prior to application of finish veneer to prevent telegraphing of patterns from the adhesive.

4. Blocking: For surface mounted hardware only, provide composite blocking designed to maintain fire resistance of door but with improved screw-holding capability of same thickness as core and with minimum dimensions as follows:

    a. 5-inch top rail blocking.
    b. 5-inch bottom rail blocking.
    c. 1 – 5" x 18" lock block at cylinder or mortise locksets.
    d. 2 – 5" x 18" lock blocks at exit devices.

5. Pairs: Provide fire-rated pairs with fire-retardant stiles that are labeled and listed for kinds of applications indicated without formed-steel edges and astragals.

2.2 RAISED PANEL WOOD DOORS

A. Provide stile-and-rail wood doors conforming to AWI "Premium" grade standards as manufactured by The Maiman Co., Algoma Hardwoods Inc. or Marshfield Door Systems Inc.

B. Construction shall conform to the following:

1. Compatibility of grain and color between veneer and lumber.

2. Type 1 Glue (PVA-waterproof).

3. Joints: Doweled and glued under pressure.

4. Stiles, rails and mullions shall be veneered construction using edge glued core material of particleboard or lumber with face veneer of 1/8" minimum thickness before sanding. Exposed edges shall be same species as face.

5. Solid Panels: Mitered rim, tongue and grooved into edge of flush panel. Miters shall be reinforced with splines. Panel face slip matched veneers. Panel edge concealed by solid sticking bead or applied molding. Panel thickness 1/2" within a 1-3/4" thick door.

    a. Panel core shall be particleboard or staved lumber core per fabricator's standard.

6. Sanding: Machine sanded with not less than 120 grit, no cross grain scratches permitted. Each door hand sanded with orbital sander.

C. Wood: As noted above.

2.3 FABRICATION

A. Prefit and premachine wood doors at the factory.

B. Comply with the tolerance requirements specified herein. Machine doors for hardware requiring cutting of doors. Comply with final hardware scheduled and door frame shop drawings, and with hardware templates and other essential information required to ensure proper fit of doors and hardware.

C. Take accurate field measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with machining in the factory.

D. Doors shall be factory sized to door opening so that trimming and fitting are not required in the field.

E. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances unless otherwise indicated.

1. Three-degree bevel or bevel to suit frame sizes indicated, with 3/16" prefit in width, +0/-1/32" tolerances. Prefit top of door 1/8" + 1/16"/-0" and undercut as required by floor condition. Undercut shall not exceed 1/8" from bottom of door to top of finished floor; where threshold occurs undercut shall not exceed 1/8" from bottom of door to top of threshold.

2. Comply with requirements in NFPA 80 for fire-rated doors.

F. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3 unless otherwise noted. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

2. Provide concealed intumescent seals at fire-rated pairs of doors meeting the requirements of U.L. 10 C.

G. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kinds of doors required.

H. Once wood doors are installed, maximum allowable warp, bow, cut or twist in doors shall be 1/16" as measured by the 1/16-inch feeler gauge and a straight-edge extending from corner to corner of the door face at stiles, top and bottom rails and along both diagonals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Section 062000 for installation of wood doors.

END OF SECTION

SECTION 083113

ACCESS DOORS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the access doors as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Frameless recessed panel access doors at drywall ceilings and walls.

2. Framed flush panel access doors at tile walls.

3. Provide access doors and frames for access from occupied spaces to the following, where indicated or required, and as directed by the trades of Divisions 23 and 26.

a. All shutoff or balancing valves.
b. Fire dampers, as required.
c. Points of duct access.
d. Pull boxes.
e. Controls of mechanical and electrical items.
f. Pipe spaces, if required.
g. Inlets of fans.
h. Fusible link and splitter damper at filter bank.
i. Automatic damper and motor.
j. Equipment not otherwise accessible.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

B. Ceramic Tiling - Section 093013.

C. Valves and connections - Division 23.

1.4 QUALITY ASSURANCE

A. For actual installation of the work of this Section, use only personnel who are thoroughly familiar with the manufacturer's recommended methods of installation and who are completely trained in the skills required.

B. Fire-Resistance Ratings: Wherever a fire-resistance classification is shown, or for construction where access doors are installed, provide required access door assembly with panel door, frame, hinge and latch from manufacturers listed in Underwriters' Laboratories, Inc. "Classified Building Materials Index" for the rating shown.

1. Provide UL label on each access panel.

2. Provide flush, key operated cylinder lock.

C. Size Variations: Obtain Architect's acceptance of manufacturer's standard size units which may vary slightly from sizes shown or scheduled.

1.5 SUBMITTALS

A. Before any materials of this Section are delivered to the job site, submit complete manufacturer's literature to the Architect. Submit plans and schedules showing size and location of each and every access door for Architect's acceptance prior to installation.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 MATERIALS AND FABRICATION

A. Provide access door assembly manufactured by Milcor Inc., Nystrom Inc., Karp Associates, Inc. or approved equal. Assembly shall be an integral unit complete with all parts and ready for installation.

B. Fabricate units of continuous welded steel construction. Grind welds smooth and flush with adjacent surfaces. Provide attachment devices and fasteners of the type required to secure access panels to the types of supports shown.

C. Frames for Masonry and Tile Wall Only (Flush Panel Units): Fabricate frame from sixteen (16) gauge steel. Provide frame with exposed flange not less than one (1) inch wide around perimeter of frame for tile finish.

D. Frameless Units for Drywall Surfaces (Recessed Panel Units): Provide access doors without exposed frames for drywall adhered to recessed panel.

E. Panels: Fabricate from fourteen (14) gauge steel, with concealed spring hinges set to open to 175 degrees. Provide removable pin type hinges of the quantity required to support the access panel sizes used in the work. Finish with manufacturer's factory applied baked enamel prime coat applied over phosphate protective coating on steel.

F. Ceiling Panels: Provide GFRG access panels with concealed frames with shell thickness of 1/8” to 3/16” equal to ceiling “Stealth” access panels by Wind-Lock or equal made by Intax Forms Inc. or Stylemark.

G. Locking Devices

1. For non-rated access doors, provide flush, screwdriver operated cam locks of number required to hold door in flush, smooth plane when closed.

2. For fire rated doors, provide locks as described in paragraph 1.4, B. herein.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where access doors are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 COORDINATION

A. Coordinate all work with the mechanical trades to insure proper locations and in a timely manner to permit orderly progress of the total work.

B. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

D. Remove and replace panels or frames which are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 083323

OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the overhead coiling doors as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Overhead coiling doors, rated and unrated.

2. Hardware and accessories.

3. Motor operation.

1.3 RELATED SECTIONS

A. Finish Hardware - Section 087100.

B. Painting and Finishing - Section 099000.

C. Electrical - Division 26.

1.4 QUALITY ASSURANCE

A. Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

B. Provide each type of overhead coiling door by one manufacturer for entire project.

C. Wind Loading: Design and reinforce exterior overhead coiling doors to withstand a thirty (30) lb. per square foot wind loading pressure, unless otherwise indicated.

D. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

E. Rated Overhead Coiling Door Assemblies

1. Furnish overhead coiling door assemblies where scheduled on drawings which comply with NFPA No. 80 and have been fire tested, rated and labeled in accordance with ANSI/ASTM E 152. Furnish each shutter with a metal UL label as evidence of rating, with label indicating rating in hours of duration of exposure to fire and letter designation of location for which assembly is designed.

2. Provide automatic closing device and governor, operating when activated by temperature rise and melting of one hundred sixty (160) degrees F. (71 deg. C.) fusible link and smoke detector. Construct governor unit to be inoperative during normal shutter operations. Design release mechanism for easy resetting.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Include operating instructions and maintenance information.

B. Shop Drawings: Submit shop drawings for special components and installations which are not fully dimensioned or detailed on manufacturer's data sheets.

C. Label Certification: Submit UL certification for fire-rated doors and frames.

D. Provide signed and seal calculations and shop drawings by a professional engineer licensed in the State of New York demonstrating compliance with Code and loads specified herin.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Provide overhead coiling doors manufactured by Atlas, Overhead Door Corp., Cornell Iron Works Inc., or approved equal meeting these specifications.

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Shutter Curtain: Fabricate overhead coiling door curtains of interlocking flat slats designed to withstand required wind loading, of continuous length for width of doors, without splices. Provide slats of structural quality, minimum twenty (20) gauge cold-rolled galvanized steel sheets complying with ASTM A 924, Grade A, with G90 zinc coating, complying with ASTM A 653, and phosphate treated before fabrication.

1. Curtain shall be insulated with 1" urethane and 22 ga. back-up sheet.

B. Endlocks: Malleable iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Windlocks: Malleable iron castings secured to curtain slats with galvanized rivets. Provide windlocks on roll-up doors approximately twenty-four (24) inches o.c. on both edges of curtain.

D. Bottom Bar: Consisting of two (2) angles, each not less than 1-1/2" x 1-1/2" x 1/8" thick, either galvanized or stainless steel or aluminum extrusions to suit type of curtain slats.

E. Curtain Jamb Guides: Fabricate curtain jamb guides of steel angles, or channels and angles with sufficient depth and strength to retain curtain loading. Build up units with minimum 3/16" thick steel sections, galvanized after fabrication. Slot bolt holes for track adjustment.

1. Secure continuous wall angle to wall framing by 3/8" minimum bolts at not more than twenty-four (24) inches o.c. Extend wall angles above overhead coiling door opening head to support coil brackets, unless otherwise shown. Place anchor bolts on exterior wall guides so they are concealed when overhead coiling door is in closed position. Provide removable stops on guides to prevent over-travel of curtain, and continuous bar for holding windlocks.

F. Weather Seals: Provide vinyl or neoprene weatherstripping for exterior doors. At door heads, use 1/8" thick continuous sheet secured to inside of curtain coil hood. At door jambs, use 1/8" thick continuous strip secured to exterior side of jamb guide.

2.3 COUNTERBALANCING MECHANISM

A. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and mounted in a spring barrel and connected to door curtain with required barrel rings. Use grease sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support curtain without distortion of slats and limit barrel deflection to not more than 0.03" per foot of span under full load.

C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

D. Fabricate torsion rod for counterbalance shaft of cast-hardened steel, of required size to hold fixed springs ends and carry torsion load.

E. Brackets: Provide mounting brackets of manufacturer's standards design, either cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.

F. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.

1. Fabricate steel hoods for doors of not less than twenty (20) gauge hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 525. Phosphate treat before fabrication.

2. At fire rated assemblies furnish automatic drop baffle to guard against passage of smoke or flame.

2.4 INSERTS AND ANCHORAGES

A. Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

B. Refer to concrete and masonry Sections of these specifications for installation of inserts and anchorage devices.

2.5 PAINTING

A. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust inhibitive primer.

2.6 ELECTRIC DOOR OPERATORS

A. Furnish electric door operator assembly of size and capacity recommended and provided by door manufacturer; complete with electric motor and factory pre-wired motor controls, gear reduction unit, solenoid operated brake, remote control stations, control devices, conduit and wiring from controls to motor and control stations, and accessories required for proper operation.

B. Provide hand operated disconnect or a mechanism for automatically engaging a sprocket and chain operator and releasing brake for emergency manual operation. Mount disconnect and operator so they are

accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

C. Design operator so that motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.

D. Door Operator Type: Provide wall or bracket mounted door operator units consisting of electric motor, worm gear drive from motor to reduction gear box, chain or worm gear drive from reduction box to gear wheel mounted on counterbalance shaft, and a disconnect-release for manual operation. Provide motor and drive assembly of horsepower and design as determined by door manufacturer for size of door required.

E. Electric Motors: Provide high starting torque, reversible, constant duty, Class A insulated electric motors with overload protection, sized to move overhead coiling door in either direction, from any position, at not less than 2/3 foot nor more than one (1) foot per second.

1. Coordinate wiring requirements and current characteristics of motors with building electrical system.

2. Furnish totally enclosed, non-ventilated type motors, fitted with plugged drain, and controller with NEMA Type 4 enclosure.

F. Remote Control Station: Provide momentary contact, 3-button control station with push button controls labeled “open,” “close,” and “stop.”

1. Provide interior units, full-guarded, surface mounted, heavy duty, with NEMA Type 4 enclosure.

G. Automatic Reversing Control: Furnish each door with automatic safety switch, extending full width of door bottom, and located within neoprene or rubber astragal mounted to bottom door rail. Contact with switch before fully closing will immediately stop downward travel and reverse direction to fully opened position. Connect to control circuit through retracting safety cord and reel, or self-coiling cable.

1. Provide electrically actuated automatic bottom bar.

H. Locking Device: Curtain shall have cylinder locking device, including cylinder and 2 deadbolts, one at each end. Provide electric interlocks that prevent motor from operating when lock is engaged.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where overhead coiling doors are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install overhead coiling door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer’s instructions, and as specified herein.

1. Install fire-rated doors to comply with NFPA 80.

B. Upon completion of installation, including work by other trades, lubricate, test and adjust overhead coiling doors to operate easily, free from warp, twist or distortion and fitting weather-tight for entire perimeter.

END OF SECTION

SECTION 084113

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the aluminum entrances and storefronts as indicated on the drawings and/or specified herein, including the following:

1. Exterior entrance and storefront systems.

2. Interior entrance and storefront systems.

3. Fixed storefront windows.

1.3 RELATED SECTIONS

A. Joint Sealers - Section 079200.

B. Finish Hardware - Section 087100.

C. Glass and Glazing - Section 088000.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.

B. Shop Drawings: Provide large scale shop drawings for fabrication, installation and erection of all parts of work. Provide plans, elevations, and details of anchorages, connections and accessory items. Provide installation templates for work installed by others. Show interfaces and relationships to work of other trades.

C. Field Measurements: Take necessary field measurements before preparation of shop drawings and fabrication. Do not delay progress of job. If field measurements are not possible prior to fabrication, allow for field cutting and fitting.

D. Initial Selection Samples: Submit samples showing complete range of colors, textures, and finishes available for each material used.

E. Verification Samples: Submit representative samples of each material that is to be exposed in completed work. Show full color ranges and finish variations expected. Provide samples having minimum size of 144 sq. in.

F. Delegated Design: Design glazed storefront, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of New York, including, but not limited to story drift, twist, column shortening, long term creep, using performance requirements and design criteria indicated.

G. Calculations: Provide professionally prepared calculations and certification of performance of this work. Indicate how design requirements for loading and other performance criteria have been satisfied; refer to Article 1.5, para. D for further description.

H. Test Reports: Provide certified test reports for specified tests.

1.5 QUALITY ASSURANCE

A. Source: For each material type required for work of this Section, provide primary materials which are products of one manufacturer. Provide secondary or accessory materials which are acceptable to manufacturers of primary materials.

B. Installer: A firm with a minimum of three years' experience in type of work required by this Section and which is acceptable to manufacturers of primary materials.

C. Design Criteria: Drawings indicate sizes, member spacings, profiles, and dimensional requirements of work of this Section. Minor deviations will be accepted in order to utilize manufacturer's standard products when, in the Architect's sole judgment, such deviations do not materially detract from the design concept or intended performances.

D. Engineering: Provide services of a Professional Engineer registered in the State of New York to design and certify that work of this Section meets or exceeds performance requirements specified.

1.6 TESTS AND PERFORMANCE REQUIREMENTS

A. Manufacturer's Standard Tests: Provide manufacturer's standard test data showing compliance with specified requirements.

B. Testing and performance data apply to exterior assemblies.

C. Test Sequence: Test sequence is optional, except that air infiltration tests shall precede water resistance tests.

D. Air Infiltration Test: Test unit in accordance with ASTM E 283, as follows:

1. Static Air Pressure Difference: 6.24 psf for fixed storefront units, and 1.567 psf for doors.

2. Performance: Maximum air leakage shall not exceed the following:

a. Fixed Storefront Units: 0.06 cfm per sq. ft. of window area.
b. Door Units: 0.50 cfm per sq. ft. of single doors, 1.00 cfm per sq. ft. for doors hinged in pairs.

E. Water Leakage Test: Test fixed framing system in accordance with ASTM E 331.

1. Test Pressure: 6.24 psf.

2. Performance: No leakage as defined in test method at specified test pressure.

F. Uniform Load Deflection Test: Test units in accordance with ASTM E 330, at following static air pressure difference (Design Wind Pressure), or loads prescribed by code for this project site, whichever is greater. Apply pressure first to exterior side (positive) and then interior side (negative).

1. Design Wind Pressure: 30 pounds per square foot minimum.

2. Test Procedure: Procedure A as specified in ASTM E 330.

3. Performance: Deflection in each member measured at locations of greatest deflection shall not exceed L/175 at specified Design Wind Pressure.

G. Uniform Load Structural Test: Test units in accordance with ASTM E 330 at following static air pressure difference. Apply high pressure load first on one side and then on other side. At conclusion of test there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms.

1. Static Air Pressure: Minimum 1.5 times the Design Wind Pressure.

2. Permanent Deformation in Any Member: Not to exceed 0.2% of member span.

H. Condensation Resistance Factor: Not less than 45 for fixed storefront units, and not less than 48 for doors; per AAMA 1502.7.

I. System U-factor Requirements per ASHRAE 90.1

1. Fixed Fenestration = 0.38 max.

2. Entrance Doors = 0.68 max.

J. Thermal Movement: Provide storefront systems that allow for expansion and contraction of members throughout an ambient temperature range of 120 degrees F.

K. Seismic Loads: Provide entrance and storefront systems, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 9, "Earthquake Loads," whichever are more stringent.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from weather damage.

B. Sequence deliveries to avoid delays, but minimize on-site storage.

1.8 WARRANTIES

A. Provide written warranty, signed by manufacturer, agreeing to repair or replace work that exhibits defects in materials or workmanship. "Defects" is defined to include, but not be limited to, leakage of water, abnormal aging or deterioration, abnormal deterioration or fading of finishes, and failure to perform as required. Include requirement for removal and replacement of covering and connected adjacent work.

1. Warranty Period: Three (3) years from date of Substantial Completion; except finish shall be warranted for a period of fifteen (15) years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/PRODUCTS

A. Provide storefronts and entrance systems of one of the following manufacturers that meet or exceed requirements of these specifications:

1. Kawneer North America.
2. Oldcastle Building Envelope.
3. Tubelite, Inc.
4. YKK AP America, Inc.

B. Products:

1. Exterior frame systems shall be equal to Series 601UT and Series 451UT manufactured by Kawneer, or approved equal by one of the manufacturers listed above.
2. Interior frame system shall be equal to Trifab II 450 manufactured by Kawneer, or approved equal by one of the manufacturers listed above.
3. Doors for interior and exterior application shall be "Narrow Stile 190" manufactured by Kawneer, or approved equal by one of the manufacturers listed above.
4. Entrance Doors: CRL Entice Entrance System, aluminum, thermally-improved, glazed entrance doors with 4-sided glass edge support, captured horizontally and vertically, as manufactured by C.R. Laurence Co., Inc.

2.2 MATERIALS AND ACCESSORIES

A. Aluminum Members: Provide 6063-T5 alloy and temper as recommended by manufacturer for strength, corrosion resistance, and application of required finish. Comply with ASTM B 221 for extrusions, and ASTM B 209 for sheet/plate. Provide 0.125" thick extrusions for door stiles and storefront framing. Provide 0.050" thick aluminum for glazing moldings.

B. Fasteners: Provide non-magnetic stainless steel fasteners, warranted by manufacturer to be non-corrosive and compatible with aluminum components.

C. Concealed Flashing: Dead-soft stainless steel, 26 gauge minimum, or extruded aluminum 0.062" minimum, of an alloy and type selected by manufacturer for compatibility with other components.

D. Brackets and Reinforcements: Non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A 123.

E. Concrete/Masonry Inserts: Cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 123.

F. Bituminous Coatings: Cold-applied asphalt mastic compounded for 30-mil thickness per coat.

G. Compression Weatherstripping: Manufacturer's standard replaceable stripping of molded neoprene or PVC gaskets complying with ASTM D 2287.

H. Sliding Weatherstripping: Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing.

I. Jamb Closure Materials: Dow 123 as manufactured by Dow Corning Corporation, 40 mil Hyload Flashing Membrane made by Hyload Inc. or equal.

2.3 HARDWARE

A. Provide hardware units as indicated, scheduled, or required for operation of each door. Refer to Section 087100, Finish Hardware for hardware description.

2.4 FABRICATION

A. Sizes and Profiles: Required sizes for door and frame units, including profile requirements, are indicated on Drawings. Any variable dimensions are indicated, together with maximum and minimum dimensions required to achieve design requirements and coordination with other work.

B. Prefabrication: To greatest extent possible, complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation.

1. Preglaze door and frame units to greatest extent possible, in coordination with installation and hardware requirements.

2. Do not drill and tap for surface-mounted hardware items until time of installation at project site.

3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work in manner which prevents damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.

C. Welding: Comply with recommendations of American Welding Society to avoid discoloration; grind exposed welds smooth and restore mechanical finish.

D. Reinforcing: Install reinforcing as necessary for performance requirements; separate dissimilar metals with bituminous paint or other separator to prevent corrosion.

E. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.

F. Fasteners: Conceal fasteners.

G. Provide EPDM/vinyl blade gasket weatherstripping in bottom exterior door rail, adjustable for contact with threshold.

H. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.

I. Provisions shall be made in the framing for minimum edge clearance, nominal edge cover, and nominal pocket width for the thickness and type of glazing installed, and shall be in accordance with the FGMA Glazing Manual.

J. Pocket glazed framing shall provide:

		Single Glass	Insulating Glass
1.	Nominal edge cover (or bite) framing only	5/16"	1/2"
2.	Min. nominal edge clearance	1/8"	1/4"
3.	Min. face clearance	1/8"	5/32"

2.5 STOREFRONT FRAMING

A. Thermal-Break Construction: Fabricate exterior aluminum storefront framing system flush and center glazed with integrally concealed, low conductance thermal barrier, located between exterior materials and exposed interior members, in manner which eliminates direct metal-to-metal contact. Provide manufacturer's standard construction which has been in use for similar projects for at least three years.

B. For glass and glazing, refer to Section 088000.

2.6 ALUMINUM DOORS

A. Aluminum entrance doors shall be narrow-stile, factory-glazed aluminum doors manufactured by same manufacturer as storefront framing.

B. Aluminum entrance doors shall be stile and rail type swing doors. Aluminum shall be extruded aluminum conforming to ASTM B 221, 0.125" thick for door stiles and 0.050" thick for glazing molding.

1. Sections shall be of sizes and profiles indicated; shall present straight, sharply defined lines and arrises; and shall be free from defects impairing strength, durability, and appearance.

2. Fasteners where exposed shall be aluminum, stainless steel, or plated steel conforming to ASTM B 633.

C. Each door shall be factory glazed set in neoprene glazing gasket, refer to Section 088000 for glass.

D. Doors shall meet the following resistance to corner racking when tested by the Dual Moment Load Test.

1. Test section shall consist of a standard top door corner assembly. Side rail section shall be 24" long and top rail section shall be 12" long.

2. Anchor top rail positively to test bench so that corner protrudes 3" beyond bench edge.

3. Anchor a lever arm positively to side rail at a point 19" from inside edge of top rail. Attach weight support pad at a point 19" from inner edge of side rail.

4. Test section shall withstand a load of 235 lbs. on the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 45 deg.

E. Air Infiltration (applies only to single acting offset pivot or butt hung entrances): Air infiltration shall be tested in accordance with ASTM E 283, at a pressure differential of 1.567 psf. A single 3'-0" x 7'-0" entrance door and frame shall not exceed 0.50 cfm per linear foot of perimeter crack. A pair of 6'-0" x 7'-0" entrance doors and frame shall not exceed 1.0 cfm per linear foot of perimeter crack.

F. For door hardware, refer to Section 087100.

G. Door bottom rail of exterior doors shall have an EPDM blade gasket sweep strip applied with concealed fasteners.

H. Corner construction shall consist of mechanical clip fastening, SIGMA deep penetration and fillet welds. Glazing stops shall be hook-in type with EPDM glazing gaskets.

I. The door weatherstripping on a single acting offset pivot or butt hung exterior door and frame (single or pairs) shall be thermoplastic elastomer weatherstripping on a tubular shape with a semi-rigid polymeric backing.

J. The door weatherstripping on a double acting, center pivoted door and frame (single or pairs) shall be pile cloth. The door bottom rail shall be weatherstripped with an EPDM blade gasket sweep strip applied with concealed fasteners.

K. The meeting stiles on pairs of doors shall be equipped with an adjustable astragal.

2.7 FINISH

A. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified

below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.

1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

2. Custom color and gloss as selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where aluminum entrances and storefronts are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install aluminum entrance doors and storefront framing in openings prepared under other Sections plumb, square, level, in exact alignment with surrounding work, with proper clearances, and securely and positively anchored to building structure, to meet performance requirements specified herein, in accordance with manufacturer's published instructions and approved submittals.

B. Use only skilled mechanics for erection, under supervision of manufacturer's representative.

C. Provide protection against galvanic action. Isolate dissimilar materials with bituminous coating or non-absorptive dielectric tape.

D. Install aluminum entrance doors, storefront frame, and finish hardware. Carefully fit and adjust doors and hardware to frames and weatherstripping. After erection check and adjust operating hardware for smooth and proper operation.

E. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction, unless otherwise indicated. Comply with requirements of Section 079200.

F. Erection Tolerances: Install entrance and storefront systems to comply with the following maximum tolerances.

1. Variation from Plane: Limit variation from plane or location shown to 1/8" in 12 feet; 1/4" over total length.

2. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16". Where surfaces meet at corners, limit offset from true alignment to 1/32".

3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8".

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform testing indicated for storefronts.

B. Test fixed frames for water infiltration per AAMA 501.2 "Hose Nozzle Water Spray Testing," latest edition. Test within the first 10% of work complete, area to be a minimum of 100 SF of wall and including a perimeter where frames adjoin adjacent construction. Interior finishes must not interfere with observation of test area or be removed from test area. Not appropriate for operable doors.

1. This test (AAMA 501.2) shall be performed infield on new construction.

2. Perform a minimum of three tests in areas as directed by Architect.

3. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35 and 70 percent completion.

C. Repair or remove Work that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

3.4 PROTECTION AND CLEANING

A. Protect finished metal surfaces from damage during fabrication, shipping, storage, and erection, and from then until acceptance by Owner.

B. Clean metal surfaces promptly after installation, exercising care to avoid damage. Remove excess sealant, dirt, and other substances. Lubricate hardware and other moving parts.

C. Replace glass that is broken, cracked or chipped prior to time of final acceptance of Project by Owner.

D. Clean glass surfaces promptly after installation, exercising care to avoid damage to same.

END OF SECTION

SECTION 084413

GLAZED ALUMINUM CURTAIN WALLS

PART 1-GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the aluminum and glass curtain wall as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Aluminum and glass curtain wall assemblies.
2. Spandrel glass panels.
3. Custom aluminum back pan panels.
4. Custom shadow box with glass.
5. Custom 1/8" thick ben aluminum fascia.
6. Glass and glazing in conjunction with the work of this Section.
7. Spandrel insulation, fire separation, fire safing and smoke stop.
8. All necessary steel or aluminum members where required to support, strengthen and/or reinforce aluminum members.
9. Sealants, caulking, joint fillers, gaskets, fasteners, vents and weeps, weep tubes, bellows, closures, gutters, end dams, flashings, trim, as shown or as may be required in conjunction with the system or to joint the system to adjacent construction.
10. Anchors, inserts and insert setting diagrams, furnishing of inserts and insert setting diagrams, support brackets, reinforcing, bracing, stiffeners, flashing.
11. Shop drawings engineering calculations, erection drawings, samples and conformance test data.
12. Field check for water leakage.
13. Protection and cleaning, as defined herein.
14. Field measurements of adjacent and/or supporting construction and verification of existing conditions.

1.3 RELATED SECTIONS

A. Thermal Insulation - Section 071200.

B. Joint Sealers - Section 079200.

C. Aluminum Entrances and Storefronts - Section 084113.

D. Glazing other than in conjunction with the metal work of this Section - Section 088000.

E. Louvers - Section 089000.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by manufacturer's documented performance criteria and field testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of New York, including, but not limited to story drift, twist, column shortening, long term creep, using performance requirements and design criteria indicated.

C. Design Wind loads (unless greater by Code): Positive Design Wind Load +/- 30 psf typical +/-50 psf at corner zones, corner zones to extend 10' from corners. The design pressures are minimum; if prevailing Code require greater pressures, such pressures shall apply.

D. Structural-Test Performance: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.

a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

F. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone in which Project is located.

1. Large-Missile Test: For glazed openings located within 30 feet of grade.

2. Small-Missile Test: For glazed openings located more than 30 feet above grade.

G. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

H. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.

I. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.

1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

J. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2. Test Interior Ambient-Air Temperature: 75 deg F.

3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

K. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.

1. Thermal Transmittance (U-factor): System U-factor requirements per ASHRAE 90.1: Fixed Fenestration = 0.38 max.; Entrance Doors = 0.68 max.

2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.37 as determined according to NFRC 200.

3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.

4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 65 as determined according to NFRC 500.

L. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Outdoor-Indoor Transmission Class: Minimum 30 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

M. Dimensional Tolerances: Provide glazed aluminum curtain wall system, including anchorage, that accommodates dimensional tolerances of building frame and other adjacent construction.

1.5 SUBMITTALS

A. Submit Product Data for each product specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

B. Submit Shop Drawings showing fabrication and installation of glazed aluminum curtain wall system including plans, elevations, sections, details of components, and attachments to other units of Work.

1. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by a professional engineer licensed in the State of New York responsible for their preparation.

C. Submit samples for verification of each type of exposed finish required in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.

D. Submit cutaway sample of each vertical-to-horizontal intersection of system, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery.

2. Anchorage.

3. Expansion provisions.

4. Glass and glazing.

5. Flashing and drainage.

E. Submit welder certificates indicating that welders comply with requirements specified in "Quality Assurance" Article.

F. Submit installer certificates signed by manufacturer certifying that installers comply with requirements in "Quality Assurance" Article.

G. Submit product test reports from a qualified independent testing agency evidencing compliance of glazed aluminum curtain wall system with requirements based on comprehensive testing of manufacturer's current system.

H. Submit test reports, calculations, computer analysis and other necessary data from a qualified independent inspecting and testing agency retained by the Contractor indicating compliance with performance requirements of glazed aluminum curtain wall system.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of glazed aluminum curtain wall systems that are similar to those indicated for this Project in material, design, and extent.

C. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing glazed aluminum curtain wall systems similar to those required for this Project and who is acceptable to manufacturer.

1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for glazed aluminum curtain wall systems, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that shows systems' compliance with specified requirements.

D. Source Limitations: Obtain each type of glazed aluminum curtain wall system from one source and by a single manufacturer.

E. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sight lines and relationships to one another and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, or in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. Welding Standards: Comply with applicable provisions of AWS D1.2, "Structural Welding Code--Aluminum."

1. Engage welders who have satisfactorily passed AWS qualification tests for welding processes involved and who are currently certified for these processes.

G. Mockups: Prior to installing glazed aluminum curtain wall system, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.

2. Notify Architect 7 days in advance of the dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Architect's approval of mockups before start of Work.

5. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

a. Approved mockups in an undisturbed condition may become part of the completed Work.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." Review methods and procedures related to glazed aluminum curtain wall system including, but not limited to, the following:

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

2. Review structural loading limitations.

3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review required inspecting, testing, and certifying procedures.

5. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace components of a glazed aluminum curtain wall system that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including, but not limited to, excessive deflection.

2. Noise or vibration caused by thermal movements.

3. Failure of system to meet performance requirements.

4. Failure of operating components to function normally.

5. Water leakage.

6. Glazing breakage.

C. Warranty Period: 10 years from date of Substantial Completion (except as noted below).

D. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products manufactured by Kawneer Company, Inc., YKK AP America, Inc., Wausau Metals Corporation or approved equal. The following model numbers are those of Kawneer; other manufacturers noted herein, or approved equal, are acceptable subject to meeting drawing details and performance criteria specified herein:

1. Kawneer Company, Inc. (basis of design)

a. Fixed Frame Assemblies: 1620 SSG, 2-1/2" sightline, 6" depth, structural silicone glazed (SSG) and Clearwall SSG, 7-1/2" depth.
b. Doors: As selected by the Architect.

2.2 METALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with the requirements of standards indicated below.

1. Sheet and Plate: ASTM B 209.

2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.

3. Extruded Structural Pipe and Tubes: ASTM B 429.

4. Structural Profiles: ASTM A 1008.

5. Welding Rods and Bare Electrodes: AWS A5.10.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plats, and Bars: ASTM A 36.

2. Cold Rolled Sheet and Strip: ASTM A 1008.

3. Hot Rolled Sheet and Strip: ASTM A 1011.

2.3 FRAMING

A. Framing Members: Extruded or formed aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.

3. Glazing Plane: Front.

B. Brackets and Reinforcements: Manufacturer's standard high strength aluminum with non-staining, non-ferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening o turning out from thermal and structural movements, wind loads, or vibration.

2. Reinforce members as required to receive fastener threads.

3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Anchors: Three-way adjustable anchors with minimum adjustment of 2" that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot dip galvanized cast iron, malleable iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.

2.4 GLASS

A. Glass shall be of the types and minimum thickness, as shown on the drawings and specified herein, and shall, in addition, meet the requirements of the following paragraphs.

B. All glass shall be the manufactured product of one (1) company. All fabricated glass products shall be the fabricated and coated products of one (1) company. All glass shall be delivered to the site bearing the manufacturer's label, complete with glazing instructions where applicable.

C. Insulating glass units shall be 1" thick (minimum), consisting of two lites of 1/4" (minimum) glass separated by a desiccant filled metal spacer with welded, fused, soldered or bent corners and welded, fused or soldered splices or joints to provide a 1/2" hermetically sealed and dehydrated space. Insulating glass shall be dual seal and certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGC) and tested in accordance with the following ASTM Test methods. Secondary seal on structural silicone glazed units shall be a special silicone edge seal certified for use in structural silicone glazing applications over the temperature range and structural loading as called for under the performance criteria section of this Specification.

1. ASTM E 2190 Standard Specification for Insulating Glass Unit Performance and Evaluation.

2. ASTM E 546-88 Standard Test Method for Frost Point of Sealed Insulating Glass Units.

3. ASTM E 576-88 Standard Test Method for Dew/Frost Point of Sealed Insulating Glass Units in Vertical Position.

D. The lites comprising insulating glass units shall be annealed, heat strengthened, (or fully tempered where required to meet wind load or safety glazing requirements), as shown, specified, required, or recommended by the specified glass fabricator to insure against heat breakage and to assure adequate glass performance at the specified design pressures specified under the performance criteria herein.

E. Glass shall conform to the requirements of ASTM C 1036. Heat strengthened and tempered glass shall conform to the requirements of ASTM C 1048. Tempered glass shall also conform to ANSI Z97.1-1975. All heat strengthening and tempering shall be by the horizontal process, and processed in such a manner as to have all roller distortion in a horizontal direction as installed on the building.

F. Fully tempered glass shall be heat soaked to EN 14179-1:2005-European Heat Soaking Standard. Glass manufacturer shall submit for approval their proposal for meeting this requirement. Heat soaked panes shall be marked to show they have been heat soaked.

G. Where glass manufacturer cannot assure adequate structural performance of insulating glass units, based upon combination of inner/outer lite, assume outer lite alone must satisfy structural requirements. Method of installation must be in accordance with the manufacturer's published literature, as well as the latest

standards of the FGMA and SIGMA. Method of installation shall make provision to weep all sill glazing rabbets.

H. Contractor shall provide certification from glass producer/fabricator that glass producer/fabricator has reviewed all glazing details and thicknesses and finds same suitable for the purpose intended in accordance with these specifications. This shall include a written wind load and thermal stress analysis showing a probability of failure of no greater than 8 lites per thousand for conventional glazing and 4 lites per thousand for structural silicone glazing at the design loads and local climatic thermal conditions.

I. Glass producer/fabricator shall make regular inspections (maximum interval semi-monthly) of glazing work in progress at the point of glazing for both mock-up and job production units to verify that glazing is proceeding in accordance with his recommendations. Glass producer/fabricator shall attend the mock-up test at no additional cost to the Owner.

J. Insulating glass units shall be installed in such manner as to adequately drain the glazing rabbet in a manner, as approved in writing, by the insulating unit glass manufacturer.

K. Contractor shall include in his design provision for reglazing vision lites with access from the interior except for structurally glazed lites which shall be reglazed from the exterior and spandrel lites with access from the exterior only. Mock-up shall include lites shop glazed in the initial installation as well as field glazed in the replacement mode.

L. Glass deflection at full design load shall be limited to the lesser of L/100 or 3/4". In event specified glass cannot meet these requirements, Contractor shall submit calculations establishing anticipated deflections and reduction in glass bite as a consequence of deflections, along with his drawings. Submittal shall include a statement from glass manufacturer/fabricator that reduction in glass bite will not result in a reduction in load resistance capacity, an increase in breakage probability and that all specified warranties shall remain in effect.

M. Glass Types: Refer to Section 088000.

2.5 GASKETS/WEATHERSTRIPPING

A. All gaskets and weather stripping shall be neoprene, except where used in contact with a silicone sealant. In contact with silicone sealants, gaskets and spacers shall be preformed, heat-cured, silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended or equal, as recommended by the sealant manufacturer and approved by the Architect. All gaskets, weather stripping, and spacers shall have continuous mechanical engagement to framing members; adhesive attachment is not acceptable. All weather strips and gaskets shall be continuous with vulcanized/molded corners where possible.

B. Sponge gaskets/weatherstripping/spacers shall be extruded black neoprene or silicone rubber (or equal as provided for in 2.4 A) with a hardness of 40 + 5 durometer Shore A and conform to ASTM C 509-79 (for neoprene). Sponge gaskets shall be compressed 20% to 35% in the final installed position.

C. Dense gaskets/weatherstripping shall be extruded black neoprene conforming to NAAMM SG-1-70 or silicone rubber (or equal as provided for in 2.04 A) with a hardness of 75 + 5 durometer Shore A for hollow profiles and 60 + 5 for solid profiles.

2.6 SEALANTS (NON-STRUCTURAL)

A. All joints, which are sealed with sealant as part of the fabrication or erection procedure, shall be sealed with an approved butyl (concealed) or low modulus silicone (exposed or concealed) sealant in color to match the adjoining surfaces or as may be required by the Architect. All perimeter sealant (metal to adjacent construction) shall be low or medium modulus silicone sealant. Silicone sealant shall be as manufactured by General Electric, Dow Corning, or Pecora. Butyl sealant shall be PTI 707.

B. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application. A primer shall be used, unless printed instructions advise to the contrary, and sealant manufacturer certifies that the use thereof will reduce its performance. Sealant shall not be applied when substrates are wet or when the temperature is below 40 deg. F.

C. Care shall be exercised to insure against "Three Surface Adhesion." Bond breakers shall be provided where necessary.

D. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and finds same suitable for the purpose intended, compatible with and will not stain the surfaces with which they are in contact. Statement as to compatibility, adhesion sufficiency and non-staining shall be accompanied by actual test results on production substrates performed in accordance with applicable ASTM procedures.

2.7 SEALANTS (STRUCTURAL)

A. All components which are adhered with a structural silicone sealant/adhesive as part of the fabrication, glazing or erection procedure, shall be sealed/adhered with an approved structural silicone, as manufactured by General Electric, Dow Corning or Pecora and approved by the Architect. All glazing with structural silicone sealant/adhesive shall be accomplished in a shop wherever consistent with the design.

B. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application. A primer shall be used, unless printed instructions advise to the contrary. Sealant shall not be applied when substrates are wet or when the temperature is below 40 deg. F. Units shall not be moved until structural silicone seal has achieved full cure.

C. Care shall be exercised to insure against "Three Surface Adhesion." Bond breakers shall be provided where necessary.

D. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and tested all contact surfaces, and finds same suitable for use with proposed sealant, the purpose intended and compatible with the surfaces with which they are in contact. Sealant manufacturer's certification shall include the following based upon tests performed on production run materials:

1. Test data of adhesion to production samples of metal and glass, tested in accordance with ASTM C 794.

2. Compatibility statement that the materials in contact with the sealant such as gaskets, spacers, setting blocks, are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt UV radiation).

3. Stress statement that when exposed to the specified wind load the stress in the silicone sealant of dimensions shown does not exceed 20 psi with a safety factor of 6:1.

E. Where silicone bonds to a metal or glass surface, the weakest element in the line of stress must have a minimum strength of 120 psi. For each combination of substrates submit report from an independent laboratory for tests performed in the following manner:

1. Assemble and fully cure a minimum of 6 samples using actual substrates and a minimum sample length of 5".

2. Subject sample to a tensile load such that nominal stress on silicone is 20 psi, hold for one minute and remove load. Repeat for additional loadings, increasing nominal silicone stress by 20 psi with each successive loading. Continue until failure occurs or until 200 psi is successfully applied.

3. All 6 samples must successfully withstand at least 120 psi. Report maximum stress and mode of failure. If one or more samples do not meet this criterion, revise failed element and repeat tests with 6 new samples. Repeat until all 6 samples are successfully tested.

4. Testing shall be performed in such a manner as to establish stress and safety factor over the temperature range described herein.

5. Prepare an outline for a quality assurance program for evaluation of adhesion and other physical attributes of sealants and submit to Architect for review and approval.

6. Program shall cover both initial testing of components for sealant adhesion/compatibility, etc., and also random testing of production run materials, etc. Include testing at full negative design pressure, one unit per one hundred units manufactured for the project. Also include methods which will be employed to monitor sealant application to insure full sealant contact. No sealant work shall be performed prior to approval of program.

2.8 GLAZING BLOCKS

A. Provide setting blocks at the sill quarter points of all glass lites. Setting blocks shall be black dense neoprene or heat cured silicone rubber with a hardness of 80 to 90 durometer, Shore A, a minimum length of 4", and a minimum width, which will permit full support of both panes of glass in an insulating glass unit or a monolithic unit no matter how positioned within the glazing rabbet.

B. Shims used in conjunction with setting blocks must be of the same materials, hardness, length and width as the setting blocks.

C. Provide side blocks within the upper half of both jambs of all glass lites. Side blocks shall be black dense neoprene or heat cured silicone rubber with a 60 to 70 durometer, Shore A, or as recommended by the selected glass manufacturer. Provide 1/8" clearance between block and bearing surface.

2.9 MISCELLANEOUS MATERIALS

A. Provide straps, plates and brackets, built-in inserts, as required for support and anchorage of the fabricated items to adjacent surfaces.

B. Where steel reinforcement of units is required for strength or other unavoidable necessity and concealed within (encased) in aluminum sections or employed in potentially wetted areas, hot dip galvanize the pieces after fabrication with 2.0 ounce zinc coating, complying with ASTM A 123. All other steel reinforcement shall be coated with two (2) heavy coats of zinc rich primer in differing colors.

C. Slip Joint Linings/Sleeves: Provide stainless steel sleeve spacers and/or suitable bearing pads, as required, to insure free movement between surfaces where expansion and deflection movements are intended. Provide "Eel Slip," "Nylatron" or high impact polystyrene shims or pads or equivalent plastic units of sizes and thicknesses (minimum 1/16" except 1/8" for "Eel Slip") recommended by the manufacturer to permanently prevent "freeze up" of joints. All sleeves, spacers, bracing pads and shims must be incombustible and rated by UL.

D. Flashing required within the system shall be 26 ga. stainless steel.

E. Flashing required to join the system to adjacent construction shall be 26 ga. stainless steel.

2.10 INSULATION AND FIRESAFING

A. Provide thermal and fire separation insulation where shown and where required. Use U.S. Gypsum Thermafiber CW 90 curtain wall insulation or approved equal with a minimum thickness of 4" (or thicker if required to meet specified thermal performance) and the foil vapor barrier (permeability not to exceed 0.020 Perms) at interior surface and all edges. Provide insulation and "fire wrap" at mullions and/or stiffeners as required to meet overall thermal and condensation resistance requirements and as required by Code.

B. Tape and seal all joints in vapor barrier and along edges and supports to insure continuous vapor barrier.

C. Apply insulation utilizing welded or screw applied impaling pins and retaining clips. Adhesive attachment will not be accepted.

D. Provide 5" thick (minimum) compacted four (4) PCF USG Thermafiber safing insulation at full perimeter at each floor level between floor edge and curtain wall to meet requirements of Building Code. Provide hourly rating as required by Code. Seal all edges with an approved fire-resistant sealant to provide a continuous fire/smoke barrier.

E. Insulation and firesafing shall be suitably isolated/separated from direct contact with spandrel glass.

2.11 THERMAL BREAK

A. Provide thermal break or thermally improved construction, complying with the requirements of these Specifications and which have been in service on comparable installations for no less than ten (10) years. Submit data to prove structural sufficiency over full exterior thermal range specified, and anticipated wind loading. In the event a structural thermal break is employed, manufacturer shall establish structural properties over full thermal range.

2.12 FABRICATION

A. General: Fabricate glazed aluminum curtain wall system according to Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.

C. Prepare components to receive concealed fasteners and anchor and connection devices.

D. Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

E. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

F. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."

G. Glazing Pockets: Provide minimum clearances for thickness and type of plastic sheet indicated according to plastic sheet manufacturer's recommendations.

H. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this

purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

I. Frame Units: Factory assemble frame units according to Shop Drawings to greatest extent possible. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Assemble components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

1. Install glazing according to approved Shop Drawings.

J. All machining, cutting and welding shall be done before finish is applied.

2.13 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Performance Organic Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed aluminum surfaces and to cut ends of aluminum to comply with coating and resin manufacturer's written instructions.

1. Fluoropolymer Two-Coat Coating System: Manufacturer's standard 2-coat, thermo-cured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat, containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

a. Color and Gloss: As selected by Architect, custom color and gloss.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of glazed aluminum curtain wall system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions for protecting, handling, and installing glazed aluminum curtain wall system. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Provide means to drain water to the exterior to produce a permanently weatherproof system.

B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

D. Install framing members plumb and true in alignment with established lines and grades.

E. Install factory-assembled frame units plumb and true in alignment with established lines and grades.

F. Install column covers plumb and true in alignment with established lines and grades.

G. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.

1. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

H. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

I. Install glazing according to approved Shop Drawings.

J. Install sealant according to approved Shop Drawings. Comply with requirements of Section 079200, "Joint Sealants."

K. Install firesafing in locations indicated. Comply with requirements of Section 078413, "Firestops and Smokeseals."

L. Erection Tolerances: Install glazed aluminum curtain wall system to comply with the following maximum tolerances:

1. Plumb: 1/16" in 10 feet; 1/8" in 40 feet.

2. Level: 1/16" in 20 feet; 1/8" in 40 feet.

3. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16"; where a reveal or protruding element separates aligned surfaces by less than 2", limit offset to 1/4".

4. Location: Limit variation from plane or location shown on Shop Drawings to 1/8" in 12 feet; 1/4" over total length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform testing indicated.

B. Static air infiltration test(s) as well as the static pressure water test(s) shall be performed on one bay at least 30 sq. ft. by one story to determine if curtain wall meets performance requirements specified herein under Article 1.4.

C. Test for water infiltration per AAMA 501.2. Test within the first 10% of work complete, area to be a minimum of 100 SF of wall and including a perimeter where CW adjoins masonry construction. Interior finishes must not interfere with observation of test area or be removed from test area. Not appropriate for operable windows and doors.

1. This test (AAMA 501.2) shall be performed infield on new construction.

2. Perform a minimum of three tests in areas as directed by Architect.

3. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35 and 70 percent completion.

D. Repair or remove Work that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure glazed aluminum curtain wall system is without damage or deterioration at the time of Substantial Completion.

END OF SECTION

Door Numbers	HwSet#
101.1	57
101.2	56
103.1	57
103.2	56
105.1	57
105.2	56
107.1	57
107.2	56
109.1	57
109.2	56
111.1	57
111.2	56
113.1	57
113.2	56
113.3	59
115.1	57
115.2	56
115.3	59
117.1	57
117.2	56
119.1	57
119.2	56
120.1	11
120.2	39
121.1	57
121.2	56
122.1	57
122.2	56
123.1	57
123.2	56
132.1	09
132.2	37
133.1	10
134.1	CO
135.1	40
136.1	CO
136.2	41
137.1	40
138.1	41
139.1	20
140.1	07
141.1	30
141.2	08
151.1	24
151.2	25
152.1	24
152.2	25
153.1	CO
154.1	CO

Door Numbers	HwSet#
154.2	21
156.1	18
156.2	13
156.3	13
156.4	17.1
157.1	19
157.2	17
157.3	13
157.4	13
157.5	13
158.1	42
158.2	42
160.1	54
160.2	54
160.3	43
161.1	53
161.2	32
161.3	45
161.4	46
161.5	47
162.1	31
164.1	56.1
164.2	56.1
168.1	30
168.2	29
168.3	28
170.1	22
177.1	49
177.2	55
177.3	49.1
179.1	27
179.2	26
181.1	32
200.1	57
200.2	56
201.1	57
201.2	58
201.3	58
202.1	57
202.2	56
205.1	57
205.2	56
207.1	57
207.2	56
209.1	57
209.2	56
210.1	57
210.2	56
211.1	57

Door Numbers	HwSet#
211.2	56
212.1	57
212.2	56
213.1	57
213.2	56
213.3	59
214.1	57
214.2	56
215.1	57
215.2	56
215.3	59
216.1	57
216.2	56
217.1	57
217.2	56
218.1	57
218.2	56
219.1	57
219.2	56
220.1	39
221.1	57
221.2	56
222.1	57
222.2	56
223.1	57
223.2	56
230.1	44.1
231.1	50
234.1	06
236.1	51
238.1	52
250.1	44
251.1	01
252.1	01
252.2	02
252.3	60
253.1	03
254.1	03
255.1	01
255.2	02
255.3	60
256.1	04
257.1	04
258.1	04
259.1	04
260.1	SL1
261.1	04
262.1	04.1
263.1	12

Door Numbers	HwSet#
263.2	16
263.3	13
264.1	12
264.2	16
264.3	13
265.1	16
266.1	16.1
267.1	39
270.1	CO
300.1	57
300.2	56
301.1	57
301.2	58
301.3	58
301.4	58
305.1	57
305.2	56
307.1	57
307.2	56
309.1	57
309.2	56
310.1	57
310.2	56
311.1	57
311.2	56
312.1	57
312.2	56
312.3	59
313.1	57
313.2	56
314.1	57
314.1	56
314.2	56
314.3	59
315.1	57
315.2	56
315.3	59
315.4	59
316.1	57
316.2	56
317.1	57
317.2	56
317.3	59
318.1	57
318.2	56
319.1	57
319.2	56
319.3	59
319.4	57

Door Numbers	HwSet#
319.5	57
319.6	56
319.7	56
320.1	39
321.1	57
321.2	56
322.1	57
322.2	56
323.1	57
323.2	56
330.1	39
331.1	15.1
332.1	06
333.1	15
349.1	05
349.2	36

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:

    a. Swinging doors.

2. Electronic access control system components

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section “Alternates” for alternates affecting this section.
2. Division 06 Section “Rough Carpentry”
3. Division 06 Section "Finish Carpentry”
4. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:

    a. “Metal Doors and Frames”
    b. “Flush Wood Doors”
    c. “Stile and Rail Wood Doors”
    d. “Interior Aluminum Doors and Frames”
    e. "Aluminum-Framed Entrances and Storefronts"
    f. “Stainless Steel Doors and Frames”
    g. “Special Function Doors”
    h. "Entrances”

6. Division 26 “Electrical” sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 “Electronic Safety and Security” sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies

2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
2. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:

a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.
b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Door Hardware Schedule:

a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.

c. Indicate complete designations of each item required for each opening, include:
   1) Door Index: door number, heading number, and Architect's hardware set number.
   2) Quantity, type, style, function, size, and finish of each hardware item.
   3) Name and manufacturer of each item.
   4) Fastenings and other pertinent information.
   5) Location of each hardware set cross-referenced to indications on Drawings.
   6) Explanation of all abbreviations, symbols, and codes contained in schedule.
   7) Mounting locations for hardware.
   8) Door and frame sizes and materials.
   9) Degree of door swing and handing.
   10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

3. Key Schedule:

   a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
   b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
   c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
   d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
   e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
   f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

4. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:

   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
   b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:

   a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Factory order acknowledgement numbers (for warranty and service)
   d. Name, address, and phone number of local representative for each manufacturer.

e. Parts list for each product.
f. Final approved hardware schedule edited to reflect conditions as-installed.
g. Final keying schedule
h. Copies of floor plans with keying nomenclature
i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
j. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit a written report of the results of functional testing and inspection for fire door assemblies, in compliance with NFPA 80.

   a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
   b. Report to include the door number for each fire door assembly, door location, door and frame material, fire rating, and summary of deficiencies.

2. Submit a written report of the results of functional testing and inspection for required egress door assemblies, in compliance with NFPA 101.

   a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
   b. Report to include the door number for each required egress door assembly, door location, door and frame material, fire rating, and summary of deficiencies.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

   a. Warehousing Facilities: In Project's vicinity.
   b. Scheduling Responsibility: Preparation of door hardware and keying schedules.
   c. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
   d. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
      1) Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.

2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:

a. For door hardware: DHI certified AHC or DHC.
b. Can provide installation and technical data to Architect and other related subcontractors.
c. Can inspect and verify components are in working order upon completion of installation.
d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.

4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:

a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

2. Smoke and Draft Control Door Assemblies:

a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.

3. Electrified Door Hardware

a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

4. Accessibility Requirements:

a. Comply with governing accessibility regulations cited in “REFERENCES” article, herein for door hardware on doors in an accessible route.

C. Pre-Installation Meetings

1. Keying Conference

a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2) Preliminary key system schematic diagram.
3) Requirements for key control system.
4) Requirements for access control.
5) Address for delivery of keys.

2. Pre-installation Conference

a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Inspect and discuss preparatory work performed by other trades.
c. Inspect and discuss electrical roughing-in for electrified door hardware.
d. Review sequence of operation for each type of electrified door hardware.
e. Review required testing, inspecting, and certifying procedures.
f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:

a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer’s original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.

1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer’s published listings.

a. Mechanical Warranty
   1) Locks
      a) Schlage Key Blanks: Lifetime
      b) Schlage L Series: 3 year
   2) Exit Devices
      a) Von Duprin: 3 year
   3) Closers
      a) LCN 4050 Series: 25 year
      b) LCN 1450 Series: 25 year
      c) LCN Concealed: 15 year
   4) Automatic Operators
      a) LCN: 2 year
   5) Accessories
      a) Ives Continuous Hinges: Lifetime

b. Electrical Warranty
   1) Locks
      a) Schlage: 1 year
   2) Exit Devices
      a) Von Duprin: 1 year

1.08 MAINTENANCE

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.

C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
4. Install hardware with fasteners provided by hardware manufacturer.

B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

C. Cable and Connectors: Hardwired Electronic Access Control Lockset and Exit Device Trim:

1. Data: 24AWG, 4 conductor shielded, Belden 9843, 9841 or comparable.
2. DC Power: 18 AWG, 2 conductor, Belden 8760 or comparable.
3. Provide type of data and DC power cabling required by access control device manufacturer for this installation.
4. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with sufficient number and wire gauge with standardized Molex plug connectors to accommodate electric function of specified hardware. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Ives 5BB series

2. Acceptable Manufacturers and Products:

a. Bommer BB series
b. PBB

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:

a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high

4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:

a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
b. Interior: Heavy weight, steel, 5 inches (127 mm) high

5. 2 inches or thicker doors:

a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
b. Interior: Heavy weight, steel, 5 inches (127 mm) high

6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

a. Steel Hinges: Steel pins
b. Non-Ferrous Hinges: Stainless steel pins
c. Out-Swinging Exterior Doors: Non-removable pins
d. Out-Swinging Interior Lockable Doors: Non-removable pins
e. Interior Non-lockable Doors: Non-rising pins

10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 SPRING HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Ives 3SP series

2. Acceptable Manufacturers and Products:

a. No Substitute

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide 3 knuckle, spring full mortise hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:

    a. Exterior: Bronze or stainless steel, 4-1/2 inches (114 mm) high
    b. Interior: Steel, 4-1/2 inches (114 mm) high

4. Doors over 1-3/4 inch (44 mm) thick or over 36 inches (914 mm) wide:

    a. Exterior: Bronze/stainless steel, 5 inches (127 mm) high
    b. Interior: Steel, 5 inches (127 mm) high

5. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
6. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.
7. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.

2.05 CONTINUOUS HINGES

A. Manufacturers:

1. Scheduled Manufacturer:

    a. Ives

2. Acceptable Manufacturers:

    a. Select
    b. Roton

B. Requirements:

1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.06 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer:

    a. Von Duprin EPT-10

2. Acceptable Manufacturers:

    a. No Substitute
    b. ABH PT1000
    c. Securitron CEPT-10

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires sufficient to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.07 PIVOT SETS

A. Manufacturers:

1. Scheduled Manufacturer:

    a. Ives

2. Acceptable Manufacturers:

    a. Dorma
    b. Rixson

B. Requirements:

1. Provide pivot sets complete with oil-impregnated top pivot, unless indicated otherwise.
2. Where offset pivots are specified, Provide one intermediate pivot for doors less than 91 inches (2311 mm) high and one additional intermediate pivot per leaf for each additional 30 inches (762 mm) in height or fraction thereof. Intermediate pivots spaced equally not less than 25 inches (635 mm) or not more than 35 inches (889 mm) on center, for doors over 121 inches (3073 mm) high.
3. Provide appropriate model where pivot sets are scheduled at fire rated openings.
4. Provide lead-lined model where pivot sets are specified at lead-lined doors.
5. Provide pivots with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electrified pivot nearest to electrified locking component. If manufacturer of electrified locking component requires another device for power transfer then provide recommended power transfer device and appropriate quantity of pivots.
6. Provide mortar guard for each electric pivot specified, unless specified in hollow metal frame specification.

2.08 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.09 SURFACE BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Requirements:

1. Surface bolt s to have 1” throw for maximum security with concealed mounting that prevents vandalism. Units to be constructed of heavy duty steel and cUL listed up to three (3) hours when used on the inactive door of a pair up to 8’ in height.

2.10 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.

2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.11 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. Schlage L9000 series

2. Acceptable Manufacturers and Products:

   a. Sargent 8200 series
   b. Best 45H series

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3 hour fire doors.
2. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
3. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
4. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
5. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
6. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

   a. Lever Design: Schlage M57/M52/LAT as specified in sets.

C. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. Von Duprin 98/35A series

2. Acceptable Manufacturers and Products:

   a. Detex Advantex series
   b. Precision APEX 2000 series

D. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to “KEYING” article, herein.
3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.

4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.
9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
13. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
14. Provide electrified options as scheduled.
15. Top latch mounting: double or single tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
16. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.12 GLASS DOOR EXIT DEVICES/DUMMY PUSH/PULL BARS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: CR Laurence DH-100 Series.
2. Acceptable Manufacturers and Products: Submit for approval.

B. Requirements:

1. Provide tubular design, style and finish as specified in sets.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide electrified options as scheduled.

2.13 ELECTRONIC ACCESS CONTROL LOCKSETS AND EXIT DEVICE TRIM

A. Manufacturers:

1. Scheduled Manufacturer and Product:

a. Schlage CO Series

2. Acceptable Manufacturers and Products:

a. No Substitute

B. Requirements:

1. Provide offline electronic access control products that comply with the following requirements:

a. Listed, UL 294 - The Standard of Safety for Access Control System Units.
b. Compliant with ANSI/BHMA A156.25 Grade 1 Operation and Security.
c. Certified to UL10C, FCC Part15, Florida Building Code Standards TAS 201 large missile impact, TAS 202 and TAS 203.
d. Compliant with ASTM E330 for door assemblies.
e. Compliant with ICC / ANSI A117.1, NFPA 101, NFPA 80, and Industry Canada RSS-210.

2. Chassis:

   a. Mortise
   b. Exit Trim

3. Functions: Provide functions as scheduled that are field configurable without taking the offline electronic product off the door.
4. Emergency Override: Provide mechanical key override; cylinders: Refer to “KEYING” article, herein.
5. Levers:

   a. Vandal Resistance: Exterior (secure side) lever rotates freely while door remains locked, preventing damage to internal lock components from vandalism by excessive force.
   b. Provide pressure cast zinc plated, non-handed lever trim that operates independently of non-locking levers.
   c. Style: Latitude.

6. Power Supply: 4 AA batteries

   a. Provide electronic access control locks and/or exit device trim with the ability to communicate battery status.

7. Features:

   a. Visual tri-colored LED indicators that indicate activation, operational systems status, system error conditions and low power conditions.
   b. Visual bi-colored LED indicator on interior that is capable of indicating secured/unsecured status of device to occupants on interior.
   c. Audible feedback that can be enabled or disabled.
   d. Onboard processor with memory capacity of 2,000 event audit history, up to 16 time zones and up to 32 calendar events.
   e. Central verification time of less than 1 second
   f. Tamper-Resistant Screws: Tamper torx screws on inside escutcheon for increased security.

8. Access:

   a. Programmable Keypad
      1) 3-6 digit PIN code and 12 backlit buttons in a 3 x 4 matrix.

9. Operation:

   a. Provide electronic access control locks and/or exit device trim with the ability to be configured at door by handheld programming device the length of time device is unlocked upon access grant.
   b. Provide electronic access control locks and/or exit device trim with the ability to communicate identifying information such as firmware versions, hardware versions, serial numbers, and manufacturing dates by handheld programming device.

10. Users:

    a. User rights to be stored on the lock.
    b. Limited to 500 users.

2.14 ACCESS CONTROL READER

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Scheduled Manufacturer and Product:

    a. Ving Vision Online.

B. Requirements: Read Only Contactless reader

2.15 ACCESS CONTROL PLATFORM

A. Manufacturers and Products:

1. Scheduled Manufacturer:

    a. Ving Vision Online

2.16 MAGNETIC LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

    a. Schlage M490 series

2. Acceptable Manufacturers and Products:

    a. Dynalock 3000 series
    b. Security Door Controls 1510 series

B. Requirements:

1. Provide magnetic locks certified to meet ANSI/BHMA A156.23 classification criteria including minimum holding force of 1,500lbs. Provide magnetic locks equipped with SPDT Magnetic Bond Sensing device, where specified, to monitor whether enough magnetic holding force exists to ensure adequate locking and SPDT Door Status Monitor device, where specified, to monitor whether door is open or closed. Provide bond sensors fully concealed within electromagnet to resist tampering or damage.
2. Provide magnetic locks certified to meet UL10C, and UL1034 for burglary-resistant electronic locking mechanisms.
3. Provide fasteners, mounting brackets, and spacer bars required for mounting and details.
4. Provide power supply recommended and approved by manufacturer of magnetic locks.
5. Where magnetic locks are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer

of magnetic locks for each individual leaf. Switches control both doors simultaneously at pairs. Locate controls as directed by Architect.

2.17 PASSIVE INFRARED MOTION SENSORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. Schlage SCAN II Series

2. Acceptable Manufacturers and Products:

   a. RCI 915 Series
   b. Security Door Controls MD-31D Series

B. Requirements:

1. Provide motion sensors as specified in hardware groups.

2.18 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. Schlage/Von Duprin PS900 Series

2. Acceptable Manufacturers and Products:

   a. Precision ELR series
   b. Security Door Controls 600 series

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:

   a. 12/24 VDC Output, field selectable.
   b. Class 2 Rated power limited output.
   c. Universal 120-240 VAC input.
   d. Low voltage DC, regulated and filtered.
   e. Polarized connector for distribution boards.
   f. Fused primary input.
   g. AC input and DC output monitoring circuit w/LED indicators.
   h. Cover mounted AC Input indication.
   i. Tested and certified to meet UL294.
   j. NEMA 1 enclosure.

k. Hinged cover w/lock down screws.
l. High voltage protective cover.

2.19 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Schlage Everest 29 R

2. Acceptable Manufacturers and Products:

a. No Substitute
b. Arrow Flexcore
c. Best Preferred Patented
d. Sargent XC
e. Yale Keymark

B. Requirements:

1. Provide cylinders/cores compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.

a. Conventional Patented Restricted Small Format: cylinder with small format interchangeable cores (SFIC) with restricted, patented keyway.

3. Nickel silver bottom pins.

C. Construction Keying:

1. Replaceable Construction Cores.

a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
1) 3 construction control keys
2) 12 construction change (day) keys.

b. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2.20 KEYING

A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Provide cylinders/cores keyed into Owner's existing keying system managed by Owner's locksmith, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference. Contact:

1. Firm Name:

2. Contact Person:
3. Telephone:

C. Requirements:

1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.

   a. Master Keying system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
3. Provide keys with the following features:

   a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)

4. Identification:

   a. Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
   b. Identification stamping provisions must be approved by the Architect and Owner.
   c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
   d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
   e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.

   a. Change (Day) Keys: 3 per cylinder/core.
   b. Permanent Control Keys: 3.
   c. Master Keys: 6.

2.21 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:

   a. Telkee

2. Acceptable Manufacturers:

   a. No Substitute
   b. HPC
   c. Lund

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and

standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.

a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
b. Provide hinged-panel type cabinet for wall mounting.

2.22 KEY LOCK BOX

A. Manufacturers:

1. Scheduled Manufacturer:

a. Knox Company

2. Acceptable Manufacturers:

a. No Substitute

B. Requirements

1. Provide Knox Box 3200 Series recessed key lock box, or equal.
2. Provide lock box meeting the requirements of UL 1037, UL 1610, UL 1332, and UL 437.
3. Provide lock box capable of storing a maximum of 10 keys.
4. Provide lock box with hinged door and weather-resistant door gasket.
5. Provide recessed mounting kit for new concrete or masonry construction.

C. Requirements:

1. Software: Provide tracking, issuing, collecting and transferring information regarding keys. Provide customized query, reporting, searching capability, comprehensive location hardware listings, display key holder photos and signature for verification, and provide automatic reminders for maintenance, back-ups and overdue keys.
2. Provide training for Owner’s personnel on proper operation and application of key management software.

2.23 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. LCN 4050 series

2. Acceptable Manufacturers and Products:

a. Falcon SC70A series
b. Sargent 351 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.

2. Provide door closers with fully hydraulic, full rack and pinion action with cast aluminum cylinder.
3. Closer Body: 1-1/2 inch (38 mm) diameter with 11/16 inch (17 mm) diameter heat-treated pinion journal and full complement bearings.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and all weather requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and back check.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide stick on templates, special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.24 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. LCN 1450 series

2. Acceptable Manufacturers and Products:

a. Falcon SC80A series
b. Sargent 1331 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide door closers with fully hydraulic, full rack and pinion action with cast aluminum cylinder.
3. Closer Body: 1-3/8 inch (35 mm) diameter with 5/8 inch (16 mm) diameter pinion journal diameter heat-treated pinion journal and full complement bearings.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Pressure Relief Valve (PRV) Technology: Not permitted.
7. Provide stick on and special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.25 CONCEALED DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. LCN 2030 series

2. Acceptable Manufacturers and Products:

    a. No Substitute

B. Requirements:

1. Provide concealed door closers at doors conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide heavy duty, single-acting closers with single lever arm and roller assembly.
3. Provide closers capable of being mounted in a minimum 1-3/4 inch header.
4. Provide concealed door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
5. Cylinder Body: 1-1/8 inch (29 mm) piston diameter, with 5/8 inch (16 mm) diameter heat-treated pinion journal.
6. Provide all-weather hydraulic fluid, fireproof, passing requirements of UL10C.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special template, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.26 CONCEALED CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

    a. LCN 2010 series

2. Acceptable Manufacturers and Products:

    a. No Substitute

B. Requirements:

1. Provide concealed door closers at doors conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Provide heavy duty, single-acting closers with single lever arm and roller assembly
4. Cylinder Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter double heat-treated pinion journal.
5. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
6. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
7. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, and adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.27 ELECTRO-MECHANICAL AUTOMATIC OPERATORS

2.28 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives.

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Requirements:

1. Provide push plates, push bars, pull plates, and pulls with diameter and length as scheduled.

2.29 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. Trimco

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.30 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:

a. Glynn-Johnson

2. Acceptable Manufacturers:

a. Sargent

b. ABH

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.31 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.32 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:

a. Zero International

2. Acceptable Manufacturers:

a. No Substitute
b. National Guard
c. Reese
d. Legacy
e. Pemko

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.33 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. Trimco

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.34 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:

a. Schlage

2. Acceptable Manufacturers:

a. GE-Interlogix
b. Sargent

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.35 DOOR VIEWERS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Auth Chimes
b. Burns

B. Provide appropriate door viewer for door type and rating with minimum of 180-degree view area.

2.36 FINISHES

A. Finish: BHMA 626/652 (US26D); except:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Continuous Hinges: BHMA 630 (US32D)
3. Continuous Hinges: BHMA 628 (US28)
4. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
5. Protection Plates: BHMA 630 (US32D)
6. Overhead Stops and Holders: BHMA 630 (US32D)
7. Door Closers: Powder Coat to Match
8. Wall Stops: BHMA 630 (US32D)
9. Latch Protectors: BHMA 630 (US32D)
10. Weatherstripping: Clear Anodized Aluminum
11. Thresholds: Mill Finish Aluminum
12. Dark Bronze as specified.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Where on-site modification of doors and frames is required:

1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
2. Field modify and prepare existing doors and frames for new hardware being installed.
3. When modifications are exposed to view, use concealed fasteners, when possible.
4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:

a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

3.03 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

H. Lock Cylinders:

1. Install construction cores to secure building and areas during construction period.
2. Replace construction cores with permanent cores as indicated in keying section.
3. Furnish permanent cores to Owner for installation.

I. Wiring: Coordinate with Division 26, ELECTRICAL sections for:

1. Conduit, junction boxes and wire pulls.
2. Connections to and from power supplies to electrified hardware.
3. Connections to fire/smoke alarm system and smoke evacuation system.
4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
5. Testing and labeling wires with Architect's opening number.

J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

L. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

M. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

N. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

O. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

P. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

Q. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

R. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Provide functional testing and inspection of fire door assemblies by a qualified person in accordance with NFPA 80.

    a. Schedule fire door assembly inspection within 90 days of Substantial Completion of the Project.
    b. Submit a signed, written final report as specified in Paragraph 1.03.E.1.
    c. Correct all deficiencies and schedule a reinspection of fire door assemblies noted as deficient on the inspection report.
    d. Inspector to reinspect fire door assemblies after repairs are made.

2. Provide inspection of required egress door assemblies by a qualified person in accordance with NFPA 101.

    a. Schedule egress door assembly inspection within 90 days of Substantial Completion of the Project for the required openings.
    b. Submit a signed, written final report as specified in Paragraph 1.03.E.2.
    c. Correct all deficiencies and schedule a reinspection of egress door assemblies noted as deficient on the inspection report.
    d. Inspector to reinspect required egress door assemblies after repairs are made.

3.05 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.

2. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.06 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items per manufacturer's instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.07 DOOR HARDWARE SCHEDULE

A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

END OF SECTION

Hardware Group No. 01

For use on Door #(s):
251.1 252.1 255.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112HD EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9827-L-DT-LBR-M57 24 VDC		US26	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9827-L-NL-LBR-M57 24 VDC		US26	VON
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	SFIC RIM CYLINDER	80-159		625	SCH
2	EA	SURFACE CLOSER	4050A SCUSH BY MFR		689	LCN
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			
1	EA	THRESHOLD	BY DOOR MFR			BYO
2	EA	WIRE HARNESS	CON-192P			SCH
2	EA	WIRE HARNESS	CON XX			SCH
2	EA	WIRE HARNESS	CON-6W			SCH
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
2	EA	DOOR CONTACT	679-05WD BY DOOR MFR		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS KL900 120/240 VAC		LGR	SCE

OPERATIONAL DESCRIPTION:
DOORS ON A SECURITY TIME SCHEDULE - ELECTRICALLY LOCKED OR UNLOCKED AT USER DISCRETION.
FREE EGRESS AT ALL TIMES.
WHEN LOCKED - VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS AND ALLOWS ENTRY.
UPON LOSS OF POWER DOORS REMAIN LOCKED (FAIL SECURE).
DOORS MONITORED.

Hardware Group No. 02

For use on Door #(s):
252.2 255.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	BY ALD MFR		US26	IVE
1	EA	INTERMEDIATE PIVOT	BY ALD MFR		625	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-98-L-NL-M57 24 VDC		US26	VON
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	SFIC RIM CYLINDER	80-159		625	SCH
1	EA	OH STOP	100S ADJ		629	GLY
1	EA	SURFACE CLOSER	4050A EDA BY DOOR MFR		689	LCN
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			
1	EA	WIRE HARNESS	CON-192P			SCH
1	EA	WIRE HARNESS	CON XX			SCH
1	EA	WIRE HARNESS	CON-6W			SCH
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
1	EA	DOOR CONTACT	679-05WD BY DOOR MFR		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS KL900 120/240 VAC		LGR	SCE

OPERATIONAL DESCRIPTION:
DOORS ON A SECURITY TIME SCHEDULE - ELECTRICALLY LOCKED OR UNLOCKED AT USER DISCRETION.
FREE EGRESS AT ALL TIMES.
WHEN LOCKED - VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS AND LLOWS ENTRY.
UPON LOSS OF POWER DOORS REMAIN LOCKED (FAIL SECURE)
DOORS MONITORED.
OPERATIONAL DESCRIPTION:
DOORS ON A SECURITY TIME SCHEDULE - ELECTRICALLY LOCKED OR UNLOCKED AT USER DISCRETION.
FREE EGRESS AT ALL TIMES.
WHEN LOCKED - VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS AND ALLOWS ENTRY.
UPON LOSS OF POWER DOORS REMAIN LOCKED (FAIL SECURE).
DOORS MONITORED..

Hardware Group No. 03

For use on Door #(s):
253.1 254.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	SURFACE CLOSER	1450 SHCUSH STD		689	LCN
3	EA	SILENCER	SR64		GRY	IVE

OPERATIONAL DESCRIPTION:

DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS DOOR.
UPON LOSS OF POWER DOOR REMAINS LOCKED.
DOOR MONITORED.

Hardware Group No. 04

For use on Door #(s):
256.1 257.1 258.1 259.1 261.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	ELECTRIFIED LOCKSET	VINGCARD ESSENCE X VALLI VALLI H1026 DIDO ALT 1 VINGCARD SIGNATURE RFID		613	ASA
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ STD		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		613	IVE
1	EA	WALL STOP	WS406/407CCV		613	IVE
3	EA	SILENCER	SR64		GRY	IVE

OPERATIONAL DESCRIPTION:

DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS DOOR.
UPON LOSS OF POWER DOOR REMAINS LOCKED.
DOOR MONITORED.

Hardware Group No. 04.1

For use on Door #(s):
262.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	ELECTRIFIED LOCKSET	VINGCARD ESSENCE X VALLI VALLI H1026 DIDO ALT 1 VINGCARD SIGNATURE RFID		613	ASA
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	OH STOP	410S		652	GLY
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ STD		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		613	IVE
3	EA	SILENCER	SR64		GRY	IVE

OPERATIONAL DESCRIPTION:

DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS DOOR.
UPON LOSS OF POWER DOOR REMAINS LOCKED.
DOOR MONITORED.

Hardware Group No. 05

For use on Door #(s):
349.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		613	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	SURFACE CLOSER	1450 SCUSH MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
3	EA	SILENCER	SR64		GRY	IVE

OPERATIONAL DESCRIPTION:

DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS DOOR.
UPON LOSS OF POWER DOOR REMAINS LOCKED.
DOOR MONITORED.

Hardware Group No. 06

For use on Door #(s):
234.1 332.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	OH STOP	90S		US10B	GLY
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	STONE THRESHOLD	BY OTHER			BYO

OPERATIONAL DESCRIPTION:

DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ OR KEY OVERRIDE MOMENTARILY UNLOCKS DOOR.
UPON LOSS OF POWER DOOR REMAINS LOCKED.
DOOR MONITORED.

Hardware Group No. 07

For use on Door #(s):
140.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	THRESHOLD	63A		A	ZER

OPERATIONAL DESCRIPTION:
DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ MOMENTARILY UNLOCKS DOOR.

Hardware Group No. 08

For use on Door #(s):
141.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		F643E/716	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	OH STOP	100S		695	GLY
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ STD		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	GASKETING	328D		D	ZER
1	SET	GASKETING	870D-S		D	ZER
1	EA	THRESHOLD	63A		A	ZER

OPERATIONAL DESCRIPTION:
DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ MOMENTARILY UNLOCKS DOOR.

Hardware Group No. 09

For use on Door #(s):
132.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 2'2" X 5'8"		613	IVE
1	EA	FLOOR STOP	FS438		613	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	STONE THRESHOLD	BY OTHER			BYO

OPERATIONAL DESCRIPTION:
DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ MOMENTARILY UNLOCKS DOOR.

Hardware Group No. 10

For use on Door #(s):
133.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X SARGENT MI LEVER		613	ASA
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	FLOOR STOP	FS438		613	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	STONE THRESHOLD	BY OTHER			BYO

OPERATIONAL DESCRIPTION:
DOOR NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ MOMENTARILY UNLOCKS DOOR.

Hardware Group No. 11

For use on Door #(s):
120.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		630	IVE
1	EA	PANIC HARDWARE	98-NL		630	VON
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	SFIC RIM CYLINDER	80-159		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4050A EDA BY DOOR MFR		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-NH-A		630	IVE
1	EA	DOOR STOP	WS401/WS402CCV/FS436 AS REQ'D		626	IVE
1	EA	DRIP CAP	142AA NOTE		AA	ZER
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	8197AA		AA	ZER
1	EA	THRESHOLD	65A-223		A	ZER

Hardware Group No. 12

For use on Door #(s):
263.1 264.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	US26D	IVE
1	EA	PULL PLATE	8302 10" 4" X 16" F	US26D	IVE
1	EA	OH STOP	90S	US32D	GLY
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ STD	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	US26D	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 13

For use on Door #(s):
156.2 156.3 157.3 157.4 157.5 263.3
264.3

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	613	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363	643e	SCH
1	EA	WALL STOP	WS406/407CCV	613	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 15

For use on Door #(s):
333.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	613	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363	643e	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC	695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	US10B	IVE
1	EA	WALL STOP	WS406/407CCV	US10B	IVE
1	EA	GASKETING	488FSBK PSA	BK	ZER

Hardware Group No. 15.1

For use on Door #(s):
331.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	613	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363	643e	SCH
1	EA	SURFACE CLOSER	1450 SCUSH MC	695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	US10B	IVE
1	EA	GASKETING	488FSBK PSA	BK	ZER

Hardware Group No. 16

For use on Door #(s):
263.2 264.2 265.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		F643E/716	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363		643e	SCH
1	EA	SURFACE CLOSER	1450 SCUSH STD		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		613	IVE
1	EA	WALL STOP	WS406/407CCV		613	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 16.1

For use on Door #(s):
266.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		F643E/716	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363		643e	SCH
1	EA	OH STOP	90S		613	GLY
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ STD		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		613	IVE
1	EA	WALL STOP	WS406/407CCV		613	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 17

For use on Door #(s):
157.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	SPRING HINGE	3SP1 4.5 X 4.5		F643E/716	IVE
1	EA	HINGE	5BB1 4.5 X 4.5		F643E/716	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363		643e	SCH
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER

NOTE: USE 90S OH STOP ON DOOR 156.4 ONLY.

Hardware Group No. 17.1

For use on Door #(s):
156.4

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	SPRING HINGE	3SP1 4.5 X 4.5		F643E/716	IVE
1	EA	HINGE	5BB1 4.5 X 4.5		F643E/716	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363		643e	SCH
1	EA	OH STOP	90S		US10B	GLY
3	EA	GASKETING	488FSBK PSA		BK	ZER

NOTE: USE 90S OH STOP ON DOOR 156.4 ONLY.

Hardware Group No. 18

For use on Door #(s):
156.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	CONCEALED PUSH/PULL PLATE	111 x 73C/73CL			ROC
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	FLOOR STOP	FS436		US10B	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 19

For use on Door #(s):
157.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	CONCEALED PUSH/PULL PLATE	111 x 73C/73CL			ROC
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	FLOOR STOP	FS436		US10B	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 20

For use on Door #(s):
139.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	PRIVACY LOCK	L9040 M52A 09-544		643e	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 21

For use on Door #(s):
154.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		625	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363		629	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US26	IVE
1	EA	WALL STOP	WS406/407CCV		625	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 22

For use on Door #(s):
170.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	PRIVACY LOCK	L9040 LATA L583-363		643e	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 24

For use on Door #(s):
151.1 152.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112HD		710	IVE
2	EA	LONG DOOR PULL	PR 9264 36" 20" N		643E/716	IVE
1	EA	CONCEALED CLOSER	2030 BUMP WMS		695	LCN
1	EA	CONC. AUTO OPERATOR	2811 STD/CP POS MS 120V / 240V AC		ANDKB	LCN
1	EA	WEATHER RING	8310-801		PLA	LCN
1	EA	ROCKER SWITCH	8310-806R		689	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853		630	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-855		630	LCN
1	EA	BOLLARD POST	8310-866		DKBRZ	LCN
2	EA	FLUSH MOUNT BOX	8310-867F		689	LCN
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			
2	EA	DOOR SWEEP	8197D		D	ZER
1	EA	THRESHOLD	545A		A	ZER

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
FREE EGRESS/ACCESS AT ALL TIMES BY DOOR PULL OR ADA OPERATOR.
BOTH ACTUATORS ALWAYS ACTIVE UNLESS SHUNTED BY ROCKER SWITCH.

Hardware Group No. 25

For use on Door #(s):
151.2 152.2

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	PIVOT SET	7256 SET		643E/716	IVE
2	EA	POWER TRANSFER	EPT10 CON		695	VON
1	EA	ELEC PANIC HARDWARE	RX-3547A-EO-CON		643E	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-3547A-NL-CON 24 VDC		643E	VON
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SFIC RIM CYLINDER	80-159		613	SCH
2	EA	LONG DOOR PULL	9264 36" 20" O		613	IVE
1	EA	CONCEALED CLOSER	2030 BUMP WMS		695	LCN
1	EA	CONC. AUTO OPERATOR	2811 STD/CP POS MS 120V / 240V AC		ANDKB	LCN
1	EA	ROCKER SWITCH	8310-806R		689	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853		630	LCN
1	EA	FLUSH MOUNT BOX	8310-867F		689	LCN
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			
2	EA	WIRE HARNESS	CON-192P			SCH
2	EA	WIRE HARNESS	CON XX			SCH
2	EA	WIRE HARNESS	CON-6W			SCH
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
2	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-4RL KL900 120/240 VAC		LGR	SCE

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
DOORS LOCKED/UNLOCKED BY SECURITY TIME SCHEDULE.
FREE EGRESS AT ALL TIMES BY EXIT DEVICE OR ADA OPERATOR.
WHEN UNLOCKED (NORMAL BUSINESS HOURS) - ACCESS BY DOOR PULL OR ADA OPERATOR.
WHEN LOCKED (AFTER HOURS) VALID CARD READ ACTIVATES VESTIBULE ADA SWITCH, ALLOWING ACCESS BY OPERATOR OR ENTRY BY DOOR PULL.
KEY OVERRIDE MOMENTARILY UNLOCKS ACTIVE LEAF.
UPON LOSS OF POWER DOORS REMAIN LOCKED (FAIL SECURE).
DOOR MONITORED.

Hardware Group No. 26

For use on Door #(s):
179.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	7256 SET		643E/716	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC		628	SCE
1	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
1	EA	CONC. AUTO OPERATOR	2811 STD/CP MS 120V / 240V AC		ANDKB	LCN
1	EA	ROCKER SWITCH	8310-806R		689	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853		630	LCN
1	EA	FLUSH MOUNT BOX	8310-867F		689	LCN
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
1	EA	PUSH BUTTON	623GREX DA 12/24 VDC		630	SCE
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		630	SCE
2	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC		BLK	SCE
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		LGR	SCE

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
DOOR ON SECURITY TIME SCHEDULE OR MAG LOCK ENERGIZED/DE-ENERGIZED LOCALLY BY KEYSWITCH.
FREE EGRESS AT ALL TIMES BY PUSH BAR OR ADA OPERATOR.
DURING NORMAL BUSINESS HOURS VESTIBULE ACTUATOR ACTIVATED BY KEYSWITCH OR SECURITY SIGNAL AND MAG LOCK UNLOCKED - ENTRY BY ADA OPERATOR OR DOOR PULL.
AFTER HOURS KEYSWITCH OR SECURITY LOCKS MAG LOCK AND DE-ACTIVATES VESTIBULE ADA ACTUATOR - NO ENTRY.
ACTUATORS SHUNTED BY ROCKER SWITCH.
UPON LOSS OF POWER OR ACTIVATION OF FIRE ALARM MAG LOCK UNLOCKS (FAIL SAFE).
DOOR MONITORED.

Hardware Group No. 27

For use on Door #(s):
179.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	7256 SET		643E/716	IVE
1	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
1	EA	CONC. AUTO OPERATOR	2811 STD/CP POS MS 120V / 240V AC		ANDKB	LCN
1	EA	WEATHER RING	8310-801		PLA	LCN
1	EA	ROCKER SWITCH	8310-806R		689	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853		630	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-855		630	LCN
1	EA	BOLLARD POST	8310-866		DKBRZ	LCN
2	EA	FLUSH MOUNT BOX	8310-867F		689	LCN
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			
1	EA	DOOR SWEEP	8197D		D	ZER
1	EA	THRESHOLD	545D-223		D	ZER

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
DOOR NORMALLY CLOSED.
FREE EGRESS/ACCESS AT ALL TIMES BY PUSH/PULL OR ADA OPERATOR.

Hardware Group No. 28

For use on Door #(s):
168.3

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	MANUAL FLUSH BOLT	FB358		613	IVE
1	EA	DUST PROOF STRIKE	DP2		643E/716	IVE
1	EA	PASSAGE SET	L9010 M51A		643e	SCH
2	EA	OH STOP	450S		US10B	GLY
2	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 29

For use on Door #(s):
168.2

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
8	EA	HINGE	5BB1 5 X 4.5		613	IVE
1	EA	MANUAL FLUSH BOLT	FB358		613	IVE
1	EA	DUST PROOF STRIKE	DP2		643E/716	IVE
1	EA	PASSAGE SET	L9010 M52A		643e	SCH
2	EA	OH STOP	450S		US10B	GLY
2	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 30

For use on Door #(s):
141.1 168.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112HD		710	IVE
1	SET	CONST LATCHING BOLT	FB62		630	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	COORDINATOR	COR X FL		711	IVE
2	EA	MOUNTING BRACKET	MB2		BLK	IVE
2	EA	SURFACE CLOSER	4050A SCUSH MC		695	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		US10B	IVE
1	EA	DRIP CAP	142D		D	ZER
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	ASTRAGAL	43SP		SP	ZER
2	EA	DOOR SWEEP	8197D		D	ZER
1	EA	THRESHOLD	545A		A	ZER

NOTE DOOR MATERIAL X FLUSH BOLT PREP

Hardware Group No. 31

For use on Door #(s):
162.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	CLASSROOM LOCK	L9070HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			

Hardware Group No. 32

For use on Door #(s):
161.2 181.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	CLASSROOM LOCK	L9070HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	SILENCER	SR65		GRY	IVE

Hardware Group No. 36

For use on Door #(s):
349.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		613	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		629	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
3	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	THRESHOLD	63A		A	ZER

Hardware Group No. 37

For use on Door #(s):
132.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 39

For use on Door #(s):
120.2 220.1 267.1 320.1 330.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112HD		628	IVE
1	EA	FIRE EXIT HARDWARE	98-L-BE-F-M57		643E	VON
1	EA	SURFACE CLOSER	4050A REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS401/402CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	8197AA		AA	ZER
1	EA	THRESHOLD	545A		A	ZER

Hardware Group No. 40

For use on Door #(s):
135.1 137.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		613	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD M52A 09-544		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	SEALS	BY ALUMINUM DOOR/FRAME MANUFACTURER			

Hardware Group No. 41

For use on Door #(s):
136.2 138.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	ELEC CLASSROOM LOCK	CO-100-MS-70-KP-LAT-G 4B BATTERY OPERATED		643e	SCE
1	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	SET	GASKETING	870D-S		D	ZER

OPERATIONAL DESCRIPTION:
DOOR NORMALLY CLOSED AND LOCKED.
INPUT OF VALID CODE TO KEYPAD OR KEY OVERRIDE ALLOWS ENTRY.
FREE EGRESS AT ALL TIMES.

Hardware Group No. 42

For use on Door #(s):
158.1 158.2

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	7256 SET		643E/716	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC		628	SCE
2	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
1	EA	CONCEALED CLOSER	2030 WMS		695	LCN
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER			
1	EA	DOOR SWEEP	BY DOOR MANUFACTURER			
1	EA	THRESHOLD	545D-223		D	ZER
1	EA	PUSH BUTTON	623GREX DA 12/24 VDC		630	SCE
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		630	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC		BLK	SCE
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		LGR	SCE

OPERATIONAL DESCRIPTION:
DOORS NORMALLY CLOSED - ON A SECURITY TIME SCHEDULE.
FREE EGRESS AT ALL TIMES - IF ACTIVE MAG LOCK DE-ENERGIZED BY PIR OR EEB.
DURING NORMAL BUSINESS HOURS MAG LOCK IS DE-ENERGIZED BY SECURITY OR LOCAL KEYSWITCH - FREE EGRESS/ENTRY AT ALL TIMES.
AFTER BUSINESS HOURS MAG LOCK IS ENERGIZED - FREE EGRESS FROM INTERIOR AND NO ENTRY FROM EXTERIOR.
MAG LOCK IS FAIL SAFE - LOSS OF POWER OR ACTIVATION OF FIRE ALARM DE-ENERGIZES MAG LOCK.

Hardware Group No. 43

For use on Door #(s):
160.3

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	PIVOT SET	7256 SET		643E/716	IVE
2	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC		628	SCE
2	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
2	EA	CONCEALED CLOSER	2030 BUMP WMS		695	LCN
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER			
2	EA	DOOR SWEEP	BY DOOR MANUFACTURER			
1	EA	THRESHOLD	545D-223		D	ZER
1	EA	PUSH BUTTON	623GREX DA 12/24 VDC		630	SCE
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		630	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC		BLK	SCE
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		LGR	SCE

OPERATIONAL DESCRIPTION:
DOORS NORMALLY CLOSED - ON A SECURITY TIME SCHEDULE.
FREE EGRESS AT ALL TIMES - IF ACTIVE MAG LOCK DE-ENERGIZED BY PIR OR EEB.
DURING NORMAL BUSINESS HOURS MAG LOCK IS DE-ENERGIZED BY SECURITY OR LOCAL KEYSWITCH - FREE EGRESS/ENTRY AT ALL TIMES.
AFTER BUSINESS HOURS MAG LOCK IS ENERGIZED - FREE EGRESS FROM INTERIOR AND NO ENTRY FROM EXTERIOR.

Hardware Group No. 44

For use on Door #(s):
250.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	PIVOT SET	7256 SET		643E/716	IVE
2	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC		628	SCE
2	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
2	EA	CONCEALED CLOSER	2030 BUMP WMS		695	LCN
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER			
2	EA	DOOR SWEEP	BY DOOR MANUFACTURER			
1	EA	THRESHOLD	545D-223		D	ZER
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
1	EA	PUSH BUTTON	623GREX DA 12/24 VDC		630	SCE
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		630	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC		BLK	SCE
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		LGR	SCE

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
DOORS NORMALLY CLOSED - ON A SECURITY TIME SCHEDULE.
FREE EGRESS AT ALL TIMES FROM EXTERIOR - IF ACTIVE MAG LOCK DE-ENERGIZED BY PIR OR EEB.
DURING NORMAL BUSINESS HOURS MAG LOCK IS DE-ENERGIZED BY SECURITY OR LOCAL KEYSWITCH - FREE EGRESS/ENTRY AT ALL TIMES.
AFTER BUSINESS HOURS MAG LOCK IS ENERGIZED - FREE EGRESS FROM EXTERIOR AND VALID CARD SWIPE FROM INTERIOR.
DOORS UNLOCK WITH LOSS OF POWER OR ACTIVATION OF FIRE ALARM (FAIL SAFE).

Hardware Group No. 44.1

For use on Door #(s):
230.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	PIVOT SET	7256 SET		643E/716	IVE
2	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC		628	SCE
2	EA	DUMMY PUSH/PULL BAR	DH-100-D		DKB	CRL
2	EA	CONCEALED CLOSER	2030 BUMP WMS		695	LCN
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER			
2	EA	DOOR SWEEP	BY DOOR MANUFACTURER			
1	EA	THRESHOLD	545D-223		D	ZER
1	EA	CREDENTIAL READER	VINGCARD ESSENCE ALT 1 VINGCARD SIGNATURE RFID			ASA
1	EA	PUSH BUTTON	623GREX DA 12/24 VDC		613	SCE
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		613	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC		BLK	SCE
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		LGR	SCE

HARDWARE MEANT FOR OPENINGS WITH 3″ MINIMUM STILE WIDTHS, 2″ MINIMUM FRAMES, 4″ MINIMUM HEADERS.

OPERATIONAL DESCRIPTION:
DOORS NORMALLY CLOSED - ON A SECURITY TIME SCHEDULE.
FREE EGRESS AT ALL TIMES FROM EXTERIOR - IF ACTIVE MAG LOCK DE-ENERGIZED BY PIR OR EEB.
DURING NORMAL BUSINESS HOURS MAG LOCK IS DE-ENERGIZED BY SECURITY OR LOCAL KEYSWITCH - FREE EGRESS/ENTRY AT ALL TIMES.
AFTER BUSINESS HOURS MAG LOCK IS ENERGIZED - FREE EGRESS FROM EXTERIOR AND VALID CARD SWIPE FROM INTERIOR.
DOORS UNLOCK WITH LOSS OF POWER OR ACTIVATION OF FIRE ALARM (FAIL SAFE).

Hardware Group No. 45

For use on Door #(s):
161.3

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112HD		710	IVE
1	EA	FIRE EXIT HARDWARE	98-EO-F		643E	VON
1	EA	ELEC EXIT DEVICE TRIM	CO-100-993R-70-KP-LAT-G 4B BATTERY OPERATED		643e	SCE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	4050A SCUSH MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	DRIP CAP	142D		D	ZER
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	8197D		D	ZER
1	EA	THRESHOLD	545D-223		D	ZER

OPERATIONAL DESCRIPTION:
DOOR NORMALLY CLOSED AND LOCKED.
INPUT OF VALID CODE TO KEYPAD OR KEY OVERRIDE MOMENTARILY ALLOWS ENTRY.
FREE EGRESS AT ALL TIMES.

Hardware Group No. 46

For use on Door #(s):
161.4

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		F643E/716	IVE
1	EA	FIRE EXIT HARDWARE	98-NL-F		643E	VON
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SFIC RIM CYLINDER	80-159		613	SCH
1	EA	SURFACE CLOSER	4050A REG OR PA AS REQ MC		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	THRESHOLD	63A		A	ZER

Hardware Group No. 47

For use on Door #(s):
161.5

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112HD		710	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB		695	VON
1	EA	FIRE EXIT HARDWARE	98-EO-F		643E	VON
1	EA	FIRE EXIT HARDWARE	98-NL-F		643E	VON
2	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SFIC MORTISE CYL.	80-133		643e	SCH
1	EA	SFIC RIM CYLINDER	80-159		613	SCH
2	EA	SURFACE CLOSER	4050A SCUSH MC		695	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		US10B	IVE
1	EA	DRIP CAP	142D		D	ZER
1	EA	GASKETING	488FSBK PSA		BK	ZER
2	EA	DOOR SWEEP	8197AA		AA	ZER
1	EA	THRESHOLD	545D-223		D	ZER

Hardware Group No. 49

For use on Door #(s):
177.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		613	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	4050A EDA		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	THRESHOLD	545D-223		D	ZER

Hardware Group No. 49.1

For use on Door #(s):
177.3

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 NRP		640	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	4050A EDA		695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		US10B	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	THRESHOLD	545D-223		D	ZER

Hardware Group No. 50

For use on Door #(s):
231.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
4	EA	LONG DOOR PULL	9264 36" 20" O		613	IVE
2	EA	OH STOP	100S		695	GLY
2	EA	SURFACE CLOSER	1450 REG OR PA AS REQ MC		695	LCN
2	EA	WALL STOP	WS406/407CCV		US10B	IVE
2	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 51

For use on Door #(s):
236.1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP		613	IVE
2	EA	MANUAL FLUSH BOLT	FB358		613	IVE
1	EA	DUST PROOF STRIKE	DP2		643E/716	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
2	EA	OH STOP	90S		US10B	GLY
2	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 52

For use on Door #(s):
238.1

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	STOREROOM LOCK	L9080HD M52A		643e	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	SURFACE CLOSER	1450 SCUSH STD		695	LCN
1	EA	GASKETING	488FSBK PSA		BK	ZER

Hardware Group No. 53

For use on Door #(s):
161.1

Provide each DA door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	PUSH PLATE	8200 4" X 16"		US10B	IVE
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		US10B	IVE
	EA		BALANCE OF HARDWARE BY DOUBLE ACTING DOOR MANUFACTURER			

Hardware Group No. 54

For use on Door #(s):
160.1 160.2

Provide each PD door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	LONG DOOR PULL	PR 9264 36" 20" N		643E/716	IVE
	EA	SLIDING DOOR HARDWARE	HAWA JUNIOR W/ SOFT CLOSE			

Hardware Group No. 55

For use on Door #(s):
177.2

Provide each RU door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
	EA	ROLL UP HW	BY ROLL UP DOOR MAUFACTURER		

Hardware Group No. 56

For use on Door #(s):

101.2	103.2	105.2	107.2	109.2	111.2
113.2	115.2	117.2	119.2	121.2	122.2
123.2	200.2	202.2	205.2	207.2	209.2
210.2	211.2	212.2	213.2	214.2	215.2
216.2	217.2	218.2	219.2	221.2	222.2
223.2	300.2	305.2	307.2	309.2	310.2
311.2	312.2	313.2	314.1	314.2	315.2
316.2	317.2	318.2	319.2	319.6	319.7
321.2	322.2	323.2			

Provide each SL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	SLIDING DOOR HW	BY SLIDING DOOR MANUFACTURER		

Hardware Group No. 56.1

For use on Door #(s):

164.1	164.2

Provide each SL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	SLIDING DOOR HW	BY SLIDING DOOR MANUFACTURER		

Hardware Group No. 57

For use on Door #(s):

101.1	103.1	105.1	107.1	109.1	111.1
113.1	115.1	117.1	119.1	121.1	122.1
123.1	200.1	201.1	202.1	205.1	207.1
209.1	210.1	211.1	212.1	213.1	214.1
215.1	216.1	217.1	218.1	219.1	221.1
222.1	223.1	300.1	301.1	305.1	307.1
309.1	310.1	311.1	312.1	313.1	314.1
315.1	316.1	317.1	318.1	319.1	319.4
319.5	321.1	322.1	323.1		

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	SFIC EVEREST CORE	80-037 EV29 R		613	SCH
1	EA	ELECTRIFIED LOCKSET	VINGCARD SIGNATURE RFID X VALLI VALLI H1026 DIDO		613	ASA
1	EA	CONCEALED CLOSER	2010 BUMP WMS		695	LCN
1	EA	FLOOR STOP	FS438		613	IVE
1	EA	GASKETING	488FSBK PSA		BK	ZER
1	EA	DOOR SWEEP	39D		D	ZER
1	EA	STONE THRESHOLD	BY OTHER			BYO
1	EA	DOOR GUARD	482		B10B	IVE
1	EA	VIEWER	U700		B10B	IVE

OPERATIONAL DESCRIPTION:
DOOR IS NORMALLY LOCKED.
FREE EGRESS AT ALL TIMES.
VALID CARD READ MOMENTARILY UNLOCKS DOOR.

Hardware Group No. 58

For use on Door #(s):

201.2	201.3	301.2	301.3	301.4

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		613	IVE
1	EA	PRIVACY	LT40 M57B		630	SCH
1	EA	FLOOR STOP	FS438		613	IVE
1	EA	WALL STOP	WS406/407CCV		US10B	IVE

Hardware Group No. 59

For use on Door #(s):

113.3	115.3	213.3	215.3	312.3	314.3
315.3	315.4	317.3	319.3		

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	613	IVE
1	EA	Exit Lock with Cylinder	L9026HD M57L	630	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R	626	SCH
1	EA	FLOOR STOP	FS438	613	IVE
1	EA	GASKETING	488FSBK PSA	BK	ZER
1	EA	DOOR BOTTOM	368D	D	ZER

Hardware Group No. 60

For use on Door #(s):

252.3	255.3

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	BALANCE OF FOLDING DOOR HARDWARE	BY MANUFACTURER		

Hardware Group No. CO

For use on Door #(s):

134.1	136.1	153.1	154.1	270.1

Provide each CO door(s) with the following:

QTY	DESCRIPTION	CATALOG NUMBER	FINISH	MFR

Hardware Group No. SL1

For use on Door #(s):

260.1

Provide each SL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
	EA	BALANCE OF SLIDING DOOR HARDWARE	BY PK 30		

SECTION 088000

GLASS AND GLAZING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the glass and glazing as shown on the drawings and/or specified herein, including, but not limited to, glazing of the following:

1. Windows.
2. Doors.
3. Curtain walls.
4. Entrances.
5. Storefront framing.
6. Interior borrowed lites.
7. Interior frameless mirrors.

1.3 RELATED SECTIONS

A. Steel Doors and Frames - Section 081113.

B. Aluminum Entrances and Storefronts - Section 084113.

C. Glazed Aluminum Curtain Walls - Section 084413.

D. Framed bathroom mirrors - Section 102813.

1.4 REFERENCES

A. Comply with the recommendations of the following references unless more stringent requirements are indicated herein.

1. FGMA Publications: FGMA Glazing Manual.
2. LSGA Publications: LSGA Design Guide.
3. IGMA Publications: TM-3000 Vertical Glazing Guidelines.
4. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201, Safety Standards for Architectural Glazing, Sealed Insulating Glass Manufacturing Association.

5. Fire-Resistive Glazing Products for Door Assemblies: Products identical to those tested per ASTM E 152, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

6. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.

7. Insulating Glass Criteria: IGCC International Glass Certification Council.

1.5 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thicknesses indicated on drawings and/or specified herein are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

a. Specified Design Wind Loads: Per ASCE-7.

2. Probability of Breakage for Vertical Glazing

a. 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
b. 1 lite per 1000 for lites installed 15 degrees from the vertical and under wind action.
c. Load Duration: 60 seconds or less.

3. Maximum Lateral Deflection: For glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/100 times the short side length or 1/2", whichever is less.

4. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

a. Temperature Change (Range): 120 deg. F ambient; 180 deg F, material surfaces.

5. Thermal Solar Performance: See Article 2.2 herein.

C. Glass units shall be annealed, heat-strengthened, fully tempered or laminated where required to meet wind load and safety glazing requirements, as shown, specified, or recommended by the glass fabricator, and as required by the prevailing Building Code.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements, including performance requirements.

B. Submit compatibility and adhesion test reports from sealant manufacturer indicating materials were tested for compatibility and adhesion with glazing sealant, as well as other glazing materials including insulation units.

C. Initial Selection Samples: Submit samples of each glass and glazing material showing complete range of colors, textures, and finishes available for each material used.

1. Submit complete range of samples of standard colors and patterns for ceramic frits at insulating glass.

2. Submit complete range of samples of sandblasted glass showing variations of grits and opacity achieved.

D. Verification Samples: Submit representative samples of each glass and glazing material that is to be exposed in completed work. Show full color ranges and finish variations expected. Provide glass samples having minimum size of 144 sq. in. and 6 in. long samples of sealants and glazing materials; all samples shall bear the name of the manufacturer, brand name, thickness, and quality.

E. Calculations: Provide wind load charts, calculations, thermal stress analysis, and certification of performance of this work. Indicate how design requirements for loading and other performance criteria have been satisfied. Document shall be signed and sealed by a Professional Engineer licensed in the State of New York.

F. Test Reports: Provide certified reports for specified tests.

G. Warranties: Provide written warranties as specified herein.

1.7 QUALITY ASSURANCE

A. Source: For each glass and glazing type required for work of this Section, provide primary materials which are products of one manufacturer. Provide secondary or accessory materials which are acceptable to manufacturers of primary materials.

B. Installer: A firm with a minimum of five years' experience in type of work required by this Section and which is acceptable to manufacturers of primary materials; and with a successful record of in-service installations similar in size and scope to this Project.

C. Glass Thickness: Glass thicknesses shown on drawings and/or specified herein are minimum thicknesses. Determine and provide size and thickness of glass products that are certified to meet or exceed performance requirements specified in this Section.

D. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated.

1. GANA Publications: GANA's "Glazing Manual" and "Laminated Glass Design Guide."

2. IGMA Publications: IGMA TM-3000, "Vertical Glazing Guidelines for Sealed Insulating Glass Units."

E. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

F. Safety Glazing Products: Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction, wherever requirements conflict the more stringent shall be required. Obtain approvals from all such authorities. As a minimum provide Category II materials complying with testing requirements in 16 CFR Part 12 and ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council.

    a. For glazing types with multiple lites of glass, laminated or assembled into an insulating unit, where safety labeling is required, provide labels that align in position and orientation from lite to lite.

2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

G. Insulating Glass Certification Program: Permanently marked on spacers with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.

2. Associated Laboratories, Inc.

3. Insulating Glass Manufacturers Alliance.

H. Manufacturer shall be ISO 9001-2000 Certified.

1.8 TESTS

A. Preconstruction Sealant Test: Submit samples of materials to be used to glazing sealant manufacturer to determine sealant compatibility. Include samples of glass, gaskets, glazing materials, framing members, and other components and accessories of glazing work. Test in accordance with ASTM C 794 to verify what type of primers (if any) are required to ensure sealant adhesion to substrates.

1. Submit minimum of nine pieces of each type and finish of framing member, and nine pieces of each type, class, kind, condition, and form of glass, including monolithic, laminated, and insulating glass for adhesion tests.

2. Provide manufacturer's written report and recommendations regarding proper installation.

1.9 PROJECT CONDITIONS

A. Weather: Perform work of this Section only when existing or forecasted weather conditions are within limits established by manufacturers of materials and products used.

B. Temperature Limits: Install sealants only when temperatures are within limits recommended by sealant manufacturer, except, never install sealants when temperatures are below 40 deg. F.

C. Do not install sealants when substrates are wet or where contaminants capable of interfering with adhesion are present.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations and GANA Manual.

1. Protect materials from moisture, sunlight, excess heat, sparks and flame.

2. Sequence deliveries to avoid delays, but minimize on-site storage.

3. Glass shall be delivered to the site bearing the manufacturer's label, complete with glazing instructions where applicable.

4. Comply with insulating glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.11 WARRANTIES

A. General: Warranties shall be in addition to, and not a limitation of, other rights the Owner may have under the Contract Documents.

B. Manufacturer's Special Project Warranty on Coated Glass Products: Provide written warranty signed by manufacturer of coated glass agreeing to furnish f.o.b. point of manufacture, within specified warranty period indicated below, replacements for those coated glass units which develop manufacturing defects. Manufacturing defects are defined as peeling, cracking or deterioration in metallic coating due to normal conditions and not due to handling or installation or cleaning practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard but not less than five (5) years after date of substantial completion.

C. Manufacturer's Special Project Warranty on Insulating Glass: Provide written warranty signed by manufacturer of insulating glass agreeing to furnish f.o.b. point of manufacture, freight allowed project site, within specified warranty period indicated below, replacements for those insulating glass units developing manufacturing defects. Manufacturing defects are defined as failure of the hermetic seal of air space (beyond that due to glass breakage) as evidenced by intrusion of dirt or moisture, internal condensation or fogging, deterioration of protected internal glass coatings, if any, and other visual indications of seal failure or performance; provided the manufacturer's instructions for handling, installing, protecting and maintaining units have been complied with during the warranty period.

1. Warranty Period: Manufacturer's standard but not less than ten (10) years after date of substantial completion.

D. Manufacturer’s Special Project Warranty on Laminated Glass: Manufacturer’s standard form, made out to Owner and signed by laminated glass manufacturer agreeing to replace laminated glass units that deteriorate as defined in “Definitions” Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty period five (5) years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/FABRICATORS

A. All glass and glazing used at the exterior of the Project shall be manufactured by the same manufacturer. The same manufacturer and the same furnace shall be used for all tempered and heat strengthened glass used throughout the project. Acceptable manufacturers include, but are not limited to, the following:

1. Viracon.

2. Vitro Architectural Glass.

3. Guardian Industries.

4. Pilkington.

5. AFG.

6. JE Berkowitz, LP.

2.2 GLASS MATERIALS AND PRODUCTS

A. Ultra-Clear (Low-Iron) Glass: Class I (clear); with a minimum 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87. Provide "OptiWhite" by Pilkington North America or approved equal.

1. Low-Iron Tempered Glass: Provide Viracon or approved equal, tempered in accordance ASTM C 1048, thicknesses as indicated.

B. Clear Float Glass: ASTM C 1036, Type I (transparent, flat), Class 1 (clear), Quality q3, minimum 1/4" thick.

C. Clear Tempered Glass: ASTM C 1048, Condition A (uncoated), Type I (transparent, flat), Class 1 (clear), Quality q3, Kind FT, minimum 1/4" thick. Tempered glass must be certified by SGCC to meet applicable standards.

1. Performance Requirements for Tempered Glass

a. Length and Width: For 2.9 mm to 6.0 mm; +/-1.6 mm.
b. Diagonal: +/- 3.0 mm.
c. Edgework: Belt seaming or diamond wheels. 1.5 mm seam of upper and lower glass edges. No sharp edges.
d. Corners: No more than 3.0 mm from square.
e. Float Glass Defects: Must meet the requirements of ASTM C 1036. The most common defects are scratches, stones gaseous bubbles and edge chips. Tables in the glass standards have limits for size/quantity of defects.
f. Tempered glass shall have a minimum surface compression of 10,000 psi.
g. Tempered glass to be heat-treated by horizontal (roller hearth) process with inherent roller-wave distortion parallel to the bottom edge of the glass when installed.
h. Flatness Tolerances
1). Roller-Wave or Ripple: The deviation from flatness at any peak shall be targeted not exceed 0.003" as measured per peak to valley for ¼" (6mm) thick glass.
2). Bow and Warp: The bow and warp tolerances shall not exceed 1/32" per linear foot.
3). Fully tempered glass shall be heat soaked to EN 14179-1:2005-European Heat Soaking Standard.

D. Laminated Safety Glass: Provide two glass panes of equal thickness, laminated together with a polyvinyl butyl interlayer, conforming to ASTM C 1172 and as follows:

1. Interlayer Color: Clear.

2. Interlayer Material: Provide Eastman Chemical "Saflex" or "Vanceva," or DuPont "Butacite," 0.030" thick at vertical applications, and 0.060" thick at sloped or horizontal applications.

3. Minimum thickness of 1/4".

E. Insulating Glass: Insulating glass unit shall consist of 1/4" clear exterior lite of float (or tempered, where required) glass with Low E coating on No. 2 face, 1/2" interspace and 1/4" clear interior lite of float (or tempered, where required) glass. Provide factory assembled units of organically sealed panes of glass enclosing a hermetically sealed dehydrated air space, complying with ASTM E 2190, and as follows:

1. Sealing System: Dual Seal.

2. Primary Sealant: Polyisobutylene.

3. Secondary Sealant: Silicone, General Electric IGS 3204 or IGS 3100, or Dow Corning 982.

    a. For structurally glazed IG units, secondary seal shall conform to ASTM C 1249.
    b. Primary and secondary seals shall not contain voids and must be continuously bonded to the glass structure.

4. Spacer: Clear finish aluminum with welded, soldered, or bent corners, hollow tube types, filled with low nitrogen absorption desiccant.

5. Desiccant: Molecular sieve, silica gel, or blend of both.

6. Interspace Content: Argon.

7. Glass Thickness: 1/4" minimum.

8. Low 'E' Coating: Provide high-performance, clear, metallic coating, as scheduled. Provide Low 'E' coating which has the following performance characteristics when applied to the No. 2 surface of 1" insulating units, both lites 1/4" clear:

    a. Visible Light Transmittance: 70%.
    b. Solar Energy Transmittance: 33%.
    c. Solar Heat Gain Coefficient (SHGC): 0.38.
    d. U-Value: 0.29 winter, 0.26 summer.

9. Units shall be certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) or by IGMA, and tested in accordance with the above ASTM Test Methods.

10. Insulating glass shall conform to the following tolerances:

    a. Length and Width: + 3.0 mm/ -2.0 mm.
    b. Diagonal: +/- 3.0 mm.
    c. Thickness: As agreed +/- 1.0 mm.
    d. Edge-Deletion of Coating: Minimum 8 mm wide. Width of deletion must be more than the width of the secondary seal. Silver layer(s) must be completely removed. Appearance must be uniform.
    e. Primary PIB Seal: Must be complete with no breaks. Appearance must be uniform. PIB bead must overlap coating. No visible bright line when glass is viewed in transmission. The width of the PIB bead shall be 4.0 mm + 3.0/ - 1.5 mm.
    f. Secondary Seal: Nominal 6 mm + 3.0/ - 1.5 mm. The minimum width of the secondary silicone seal for IG units that are glazed structurally must be determined according to ASTM C 1249. The secondary seal must be uniformly applied without bubbles, cavities or gaps. Avoid excess sealant that will need to be trimmed off later.

11. Additional requirements and properties for primary and secondary insulating glass seals and spacers:

    a. All glass units shall comply with IGMA Guidelines which limits the dimension of the visible edge seal encroachment into the vision area to be no greater than the sightline infringement of 3mm (0.12").
    b. Insulating glass unit hermetic seal to consist of butyl primary and silicone secondary seals with bent, welded, or soldered interpane spacer corners; keyed corners are not acceptable unless also soldered or welded. Spacers shall be aluminum or stainless steel. Locate spacer joint at the top or sides of the units, but in no instances at the sill. Design units to minimize the

number of spacer joints. Provide solid keys, embedded in butyl sealant on all four sides, at spacer joints.

c. Hermetic seals must be continuous and intimately bonded to both lites of glass. Provide primary seal of uniform depth with a nominal width of 1/8" to 3/16". Hermetic seals shall not be contaminated with debris, fingerprints, or other foreign matter and shall not contain voids or air pockets that decrease the width of the seal below the minimum widths listed in these Specifications, or that breach the seal. The width of the primary seal shall not be less than 1/16", and the total cumulative length of the primary seal between 1/16" and 1/8" shall be less than 12" in any one insulating glass unit. The primary seal shall not have a reduced thickness at the corners. An increased thickness of the primary seal at the corners is acceptable.

d. Provide secondary seal of uniform depth with a nominal width of ¼". Provide a total width of the primary and secondary seal of ½". Units shall meet IGMA 65-7-2, latest edition. Units shall not contain breather or capillary tubes or similar penetrations.

F. Ceramic Frit Spandrel Glass

1. Heat-treated glass with ceramic coating complying with ASTM C 1048, Condition B (spandrel glass, one surface ceramic-coated) Type 1 (Transparent, Flat), Quality Q3 (Glazing Select), with other requirements as specified.

2. GANA/GTA 66-9-20, Specification for Heat-Strengthened or Fully Tempered Ceramic Enamel Spandrel Glass Used for Building Window/Curtain Walls.

3. Custom color selected by the Architect.

G. Frameless Mirrors: 1/4", Quality q2, clear float glass with silver, copper, and organic coating, edges uniformly ground and polished.

H. Frosted Bronze Mirrors: Frosted bronze glass as manufactured by Bendheim on 3/4" thick honeycomb core panel; SatinTech etched, tempered glass; refer to Materials List on drawings.

2.3 EXTERIOR GLASS TYPES

A. Institute

1. Type 1: Per Material Schedule and drawings.

2. Type 2: Per Material Schedule and drawings.

B. Lobby/Inn

1. Type 3: VNE24-63 clear.

2.4 GLAZING MATERIALS AND PRODUCTS

A. General: Provide sealants and gaskets with performance characteristics suitable for applications indicated. Ensure compatibility of glazing sealants with insulating glass sealants, with laminated glass interlayers, and with any other surfaces in contact.

B. General Glazing and Cap Bead Sealant: Provide sealant with maximum Shore A hardness of 50. Provide one of the following:

1. Dow Corning 795.

2. General Electric Silglaze N 2500 or Contractors SCS-1000.

3. Tremco Spectrem 2.

C. Weather Seal Sealant: Provide non-acid curing sealant with movement range ± 50%, ASTM C 719. Provide one of the following:

1. Dow Corning 795.

2. General Electric Silpruf.

3. Tremco Spectrem 2.

D. Backer Rod: Closed cell non-gassing polyethylene rod with rod diameter 25% wider than joint width.

E. Dense Elastomeric Compression Seal Gaskets: Provide molded or extruded neoprene or EPDM gaskets, Shore A hardness of 75±5 for hollow profile, and 60±5 for solid profiles, ASTM C 864.

F. Cellular, Elastomeric Preformed Gaskets: Provide extruded or molded closed cell, integral-skinned neoprene, Shore A 40±5, and 20% to 35% compression, ASTM C 509; Type II.

G. Preformed Glazing Tape: Provide solvent-free butyl-polyisobutylene rubber with 100% solids content complying with ASTM C 1281 AAMA A 800 with integral continuous EPDM shim. Provide preformed glazing tape in extruded tape form. Provide Tremco "Polyshim II" or approved equal.

H. Setting Blocks: Provide 100% silicone blocks with Shore A hardness of 80-90. Provide products certified by manufacturer to be compatible with silicone sealants. Length to be not less than 4". Width for setting blocks to be 1/16" more than glass thickness and high enough to provide the lite recommended by glass manufacturer. When thickness of setting block exceeds 3/4" the glass manufacturer must be consulted for sizes and configuration. In a vented system, setting block shall be designed so as to not restrict the flow of water within the glazing rabbet to the weep holes.

1. Shims: For shims used with setting blocks, provide same materials, hardness, length and width as setting blocks.

2. Structural Silicone Glazing: Provide silicone setting blocks where structural silicone occurs at sills and at insulating units with silicone edge seals.

I. Edge Blocks: Provide neoprene or silicone as required for compatibility with glazing sealants. Provide blocks with Shore A hardness of 55±5.

J. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place.

K. Miscellaneous Glazing Materials: Provide sealant backer rods, primers, cleaners, and sealers of type recommended by glass and sealant manufacturers.

L. Mirror Adhesive: Palmer's "Mirro-Mastic," or approved equal. Mastic must be compatible with mirror backing.

1. Clips: No. 4 finish Type 304 stainless steel.

2.5 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.

C. Grind smooth and polish exposed glass edges.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine glazing framing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep system.

3. Minimum required face or edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GENERAL GLAZING STANDARDS

A. Install products using the recommendations from the manufacturer of glass, sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those in the GANA "Glazing Manual."

B. Verify that Insulating Glass Unit (IGU) secondary seal is compatible with glazing sealants.

C. Install glass in prepared glazing channels and other framing members.

D. Install setting blocks in rabbets as recommended by referenced glazing standards in GANA's "Glazing Manual" and IGMA's "Glazing Guidelines."

E. Provide bite on glass, minimum edge and face clearances and glazing material tolerances recommended by GANA's "Glazing Manual."

F. Provide weep system as recommended by GANA's "Glazing Manual."

G. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics.

H. Distribute the weight of glass unit along the edge rather than the corner.

I. Comply with manufacturers and referenced industry standards on expansion joint and anchors; accommodating thermal movement; glass openings; use of setting blocks, edge, face, and bite clearances; use of glass spacers; edge blocks and installation of weep systems.

J. Protect glass edge damage during handling and installation.

K. Prevent glass from contact with contaminating substances that result from construction operations, such as weld spatter, fireproofing or plaster.

L. Remove and replace glass that is broken, chipped cracked or damaged in any way.

3.4 GLAZING

A. Glazing channel dimensions, as indicated on Shop Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead. Install setting blocks at the one greater points of each lite along the horizontal mullion.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where the length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

K. Flush Glazing

1. If the butt joint in the metal framing is in the vertical direction, the glazier shall run the tape initially on the head and sill members going directly over this joint. Should the butt joint in the metal framing run horizontally, tapes must first be applied to the jambs so that it crosses over the joint.

2. Each tape section shall butt the adjoining tape and be united with a tool to eliminate any opening.

3. Do not overlap the adjoining length of tape or rubber shim as this will prevent full contact around the perimeter of glass.

L. Off-Set Glazing

1. Where the glazing legs are off-set, the difference in the rabbet width shall be compensated by employing different glazing tapes with different diameter shims. The difference in shim shall be equal to the size of the off-set. The thinner tape shall be positioned first on the glazing leg closest to the interior. The thicker tape shall be cut to the exact length of the dimension between the applied tapes, and installed on the outermost glazing leg.

2. Immediately prior to setting glass, paper backing shall be removed. Apply a toe bead of sealant 6" in each direction, from each corner.

3. Locate setting blocks in the sill member at quarter points, or if necessary to within 6" of each corner. Setting blocks must be set equal distance from center line of the glass and high enough to provide the recommended bite and edge clearances.

4. Set edge block according to glass manufacturer's recommendations.

5. Set Glass: The glass shall be pressed firmly against the tape to achieve full contact.

6. In a vented system, apply a heel bead (air seal) of sealant around the perimeter of glass, between the sole of the I.G. unit and the base of the rabbet of the metal framing developing a positive bond to the unit and to the metal framing. The bead of the sealant shall be deep enough so that it will partially fill the channel to a depth of 1/4" between the glass edge and the base of the metal framing rabbet.

7. Interior stops shall be set, and glazing tape spline for the appropriate face clearance shall be rolled into place, compressing the glass to the shim within the glazing tape.

3.5 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant as recommended by glass manufacturer or glass frame manufacturer.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape where noted on approved shop drawings.

3.6 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.7 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

1. Exterior glazing gasket shall be set a minimum of 1/8" below exterior glazing stop to create a channel for sealant installation.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.8 FRAMELESS MIRRORS

A. Apply mastic to back of mirror "pats" spaced 4 pats/sq. ft.; adjust mirror so that it is plumb and in place to avoid distortion of reflecting images. Allow 1/8" space between back of mirror and wall surface.

1. Apply "pats" using Palmer Electric Applicator.

B. Apply stainless steel clips at mirror top and bottom; securely clip to substrate using non-corrosive anchors. At drywall back-up anchors must be secured to studs or steel wallplate spanning from stud to stud.

3.9 PROTECTION AND CLEANING

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.

E. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.

F. Glass to be cleaned according to:

1. GANA Glass Information Bulletin GANA 01-0300 – "Proper Procedure for Cleaning Architectural Glass Products."

2. GANA Glass Informational Bulletin GANA TD-02-0402 – Heat Treated Glass Surfaces are Different."

G. Do not use razor blades, scrapers or metal tools to clean glass.

END OF SECTION

SECTION 089000

LOUVERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the louvers as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Aluminum louvers.

2. Blank-off panels.

3. Bird screens.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Joint Sealers - Section 079200.

C. Glazed Aluminum Curtain Wall - Section 084413.

D. Louvers connected to ductwork - Division 23.

1.4 QUALITY ASSURANCE

A. Structural Performance: Provide exterior metal louvers capable of withstanding the effects of loads and stresses from wind and snow and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter or permanent damage to fasteners and anchors.

1. Wind Load: As required by the 2015 International Building Code, New York edition, as based on ASCE 7-05.

B. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects.

1. Temperature Change (Range): 120 deg. F., ambient; 180 deg. F, material surfaces.

C. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.

D. Field Measurements: Verify size, location and placement of louver units prior to fabrication.

E. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

F. Louvers shall be tested and certified AMCA 500-L, AMCA 540 and AMCA 550 compliant.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, certified test data, where applicable, and installation instructions for required products, including finishes.

B. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.

C. Samples: Submit six (6) inch square samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work. Where normal color and texture variations are to be expected, include two (2) or more units in each sample showing limits of such variations.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

1.7 WARRANTY

A. Finish shall be warranted for a period of 20 years, starting from date of Substantial Completion of the Project.

PART 2 PRODUCTS

2.1 LOUVER MATERIAL

A. Provide storm-resistant, drainable blade, fixed horizontal louvers as manufactured by Construction Specialties, Greenheck, Reliable, or approved equal meeting these specifications.

1. All louvers must have 50% free area.

B. Heads, sills, jambs, blades and mullions to be one-piece structural members of 6063-T6 alloy, with integral caulking slot and retaining beads. Closed cell PVC compression gaskets to be provided between bottom of mullion or jamb and top of sill to insure lead tight connections. Concealed structural supports to be designed by the louver manufacturer to carry a wind load of not less than forty (40) lbs. per square foot. All fasteners to be stainless steel.

C. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-chromate-fluoride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer’s written instructions.

1. Fluoropolymer Two-Coat System: Manufacturer’s standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

2. Custom color and gloss as selected by the Architect.

D. Bird Screens

1. All louvers to be furnished with bird screens, finish to match louvers.

2. Screens to be 5/8" mesh, 0.050" thick expanded and flattened aluminum bird screen secured with 0.055" thick extruded aluminum frames. Frames to have mitered corners and corner locks.

E. Provide aluminum blank-off panels behind louvers where shown on mechanical drawings, fabricated from 1/8" thick aluminum face sheets, finish to match louvers; reinforce as required to form rigid assembly. Blank-off panels shall be insulated with Thermafiber insulation of thickness needed to insure an R value of eleven (11).

F. Fastenings: Fasteners for exterior application shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.

G. Anchors and Inserts: Use non-ferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

H. Bituminous Paint: SSPC-Paint 12 (cold applied asphalt mastic).

2.2 LOUVER FABRICATION, GENERAL

A. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining work.

B. Include supports, anchorages, and accessories required for complete assembly.

C. Provide sill extensions made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

D. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are necessary by size of louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where louvers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in masonry construction. Coordinate the delivery of such items to the project site.

3.3 INSTALLATION

A. Comply with manufacturer’s instructions and recommendations for installation of the work.

B. Verify dimensions of supporting structure at the site by accurate field measurements so that the work will be accurately designated, fabricated and fitted to the structure.

C. Anchor louvers to the building substructure.

D. Erection Tolerances:

1. Maximum variation from plane or location shown on the approved shop drawings: 1/8” per 12 feet of length, but not exceeding ½” in any total building length or portion thereof (non-cumulative).

2. Maximum offset from true alignment between two members abutting end to end, edge to edge in line or separated by less than 3": 1/16" (shop or field joints). This limiting condition shall prevail under both load and no-load conditions.

E. Cut and trim component parts during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely. Remove and replace members where cutting and trimming has impaired the strength or appearance of the assembly.

F. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.

G. Set units level, plumb and true to line, with uniform joints.

3.4 PROTECTION

A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

3.5 ADJUSTING AND CLEANING

A. Immediately clean exposed surfaces of the louvers to remove fingerprints and dirt accumulation during the installation process. Do not let soiling remain until the final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to the material finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and accessory components damaged during installation and construction so no evidence remains of corrective wok. If results of restoration are unsuccessful, as determined by the Architect, remove damaged materials and replace with new materials.

1. Touch up minor abrasions in finishes with a compatible air-dried coating that matches the color and gloss of the factory applied coating.

END OF SECTION

DIVISION 09
FINISHES

SECTION 092900

GYPSUM DRYWALL

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the gypsum drywall as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Gypsum board work for partitions, ceilings, column enclosures, furring, and elsewhere where gypsum drywall work is shown on drawings.

2. Metal supports for gypsum drywall construction.

3. Acoustical insulation for gypsum drywall work.

4. Sealant for gypsum drywall work.

5. Concealed metal reinforcing for attachment of railings and other items supported on drywall partitions and walls.

6. Taping and finishing of drywall joints.

7. Installing rings and frames in drywall surfaces for grilles, registers and lighting fixtures.

8. Gypsum wallboard cants at beams and other projections over 2" deep in elevator shafts where adjoining wall is of gypsum wallboard construction.

9. Gypsum shaft wall construction.

10. Bracing and connections.

1.3 RELATED SECTIONS

A. Thermal Insulation - Section 072100.

B. Hollow metal door frames - Section 081113.

C. Access Doors - Section 083113.

D. Interior Stone Cladding - Section 097500.

E. Painting and Finishing - Section 099000.

F. Elevators - Division 14.

G. Rings for grilles, registers and light fixtures - Division 23 and 26.

1.4 QUALITY ASSURANCE

A. The following standards, as well as other standards which may be referred to in this Section, shall apply to the work of this Section:

1. The Gypsum Construction Handbook, latest edition, USG.

2. Construction Guide, latest edition, National Gypsum.

3. ASTM A 568 "Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements For"

4. ASTM C 475 "Standard Specification for Joint Treatment Materials for Gypsum Wallboard Construction"

5. ASTM C 645 "Standard Specification for Non-Structural Steel Framing Members"

6. ASTM C 754 "Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products"

7. ASTM C 840 "Standard Specification for Application and Finishing of Gypsum Board"

8. ASTM C 919 "Standard Specification for Use of Sealants in Acoustical Applications"

9. ASTM C 954 "Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs From 0.033 in. to 0.112 in. in Thickness"

10. ASTM C 1002 "Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Board"

11. ASTM C 1177 "Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing"

12. ASTM C 1178 "Standard Specification for Glass Mat Water Resistant Gypsum Backing Board"

13. ASTM C 1278 "Standard Specification for Fiber-Reinforced Gypsum Panel"

14. ASTM C 1396 "Standard Specification for Gypsum Board"

15. ASTM D 3273 "Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber"

B. Allowable Tolerances: 1/32" offsets between planes of board faces, and 1/16" in 8'-0" for plumb, level, warp and bow.

C. System Design Load

1. Provide drywall shaft systems for elevators designed and tested by manufacturer to withstand a lateral loading (air pressure) of 10 lbs. per sq. ft. for the maximum wall height required, and with deflection limited to L/240 of partition height.

2. Provide standard drywall wall assemblies designed and tested by manufacturer to withstand a lateral load of 5 lbs. per sq. ft. for the maximum wall height required, and with deflection limited to L/240 of partition height.

a. Drywall assemblies with tile finish shall have a deflection limit of L/360.
b. Drywall assemblies with stone slab finish shall have a deflection limit of L/720.

3. Provide drywall ceiling assemblies designed, fabricated and installed to have a deflection not to exceed L/360.

D. Fire-Resistance Rating: Where gypsum drywall with fire resistance ratings are indicated, provide materials and installations which are identical with those of applicable assemblies tested per ASTM E 119 by fire testing laboratories, or to design designations in UL "Fire Resistance Directory" or in listing of other testing agencies acceptable to authorities having jurisdiction, and compliant with UL Test #2079; criteria for cycle movement for all field height wall sections requiring allowance for vertical deflection within framing details.

E. Installer: Firm with not less than 5 years of successful experience in the installation of specified materials.

F. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association (SFIA) or be a part of a similar organization that provides verifiable code compliance program.

1.5 SUBMITTALS

A. Submit shop drawing for each drywall partition, furring and ceiling system showing size and gauges of framing members, hanger and anchorage devices, wallboard types, insulation, sealant, methods of assembly and fastening, control joints indicating column lines, corner details, joint finishing and relationship of drywall work to adjacent work.

B. Samples: Each material specified herein, 12" x 12", or 12" long, or in manufacturer's container, as applicable for type of material submitted.

C. Manufacturer's Literature: Submit technical and installation instructions for each drywall partition, furring and ceiling system specified herein, and for each fire-rated and sound-rated gypsum board assembly. Submit other data as required to show compliance with these specifications, including data for mold resistant joint compound.

D. Test Reports: This Contractor shall submit test report, obtained by drywall manufacturer, indicating conformance of drywall assemblies to required fire ratings and sound ratings.

E. Evaluation Reports: Submit evaluation reports certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98, IAS Accreditation Criteria for Inspection Agencies.

F. Engineering Data for Walls with Stone Slab Walls

1. Submit Engineering Data drawings to the Architect for review. The Contractor is responsible for the structural design and supports for the metal framing and must show his proposed system and how the Performance Criteria noted below is accommodated on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

1.6 PRODUCT HANDLING AND PROTECTION

A. Deliver, store and handle drywall work materials to prevent damage. Deliver materials in their original, unopened containers or bundles, and store where protected from moisture, damage and from exposure to the elements. Store wallboard in flat stacks.

B. Protect wallboard from becoming wet.

C. Protect metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI's "Code of Standard Practice."

1.7 ENVIRONMENTAL CONDITIONS

A. Provide and maintain minimum temperature of fifty-five (55) degrees F. and adequate ventilation to eliminate excessive moisture within the building in the area of the drywall work for at least twenty-four (24) hours, prior to, during and after installation of drywall work. Installation shall not start until windows are glazed and doors are installed, unless openings are temporarily closed. Space above suspended ceilings shall be vented sufficiently to prevent temperature and pressure build up.

1.8 JOB MOCK-UP

A. At a suitable location, where directed by the Architect, lay up a portion of a finished wall and ceiling demonstrating the quality of work, including finishing, to be obtained under this Section. Omit drywall boards in locations as directed by the Architect to show stud spacing and attachments; after acceptance, complete assembly.

B. Adjust the finishing techniques as required to achieve the finish required by the Architect as described in this Section of these specifications.

C. Upon approval of the mock-up, the mock-up may be left in place as a portion of the finished work of this Section.

D. All drywall work shall be equal in quality to approved mock-up.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers for Gypsum Drywall Panels and Accessories: U.S. Gypsum Co., Georgia Pacific, CertainTeed Corporation, Continental Building Products, or National Gypsum Co. meeting specification requirements are acceptable.

1. All drywall products must be manufactured in North America.

B. Acceptable Manufacturers for Metal Supports of Drywall Assemblies: Unless otherwise noted, provide products manufactured by ClarkDietrich, Super Stud Building Products, Marino/Ware, or approved equal.

2.2 METAL SUPPORTS

A. Metal Floor and Ceiling Runners

1. Drywall Track: Formed from 0.0312 inch (20 U.S. Std. gauge) (minimum unless otherwise noted or required by performance requirements) cold formed steel, width to suit shaped metal studs. Use 20 ga. top runners with 1-1/4" minimum flanges.

2. Deflection track or head of wall connections at rated partitions shall conform to UL #2079 for cycle movement. Provide positive mechanical connection of framing to structure, allowing for vertical movement within connections. Minimum of 0.0312 (20 ga.) cold formed steel for clips, 25 ga. cold formed steel for deflection track.

a. Product: "BlazeFrame DSL" or "MaxTrak Slotted Deflection Track" as manufactured by ClarkDietrich, "VertiClip" or "VertiTrack" as manufactured by the Steel Network or equal made by Metal-Lite Inc.
b. FireTrak (including stud clips) by FireTrak Corp. or equal made by Metal-Lite Inc.

3. Shaft Wall "J" Type Runner: Formed from 0.0329" (20 U.S. Std. gauge) galvanized steel, 1" x 2-1/2" or 4" wide (to suit detail) x 2-1/4" (for shaft wall).

B. Metal Studs, Framing and Furring

1. C-Shaped Studs: Channel type with holes for passage of conduit formed from minimum 0.0312" (20 U.S. Std. gauge) (unless heavier gauge is required to meet deflection limits) cold formed steel, width as shown on drawings. Use 0.0188" (25 U.S. Std. gauge) studs at residential unit demising walls and residential unit level corridor walls, (unless heavier gauge is required to meet deflection limits) at which time Architect shall be notified.

2. Furring Channels: Hat shaped, formed from galvanized steel, 25 U.S. Std. gauge.

   a. Product: ClarkDietrich; Furring Channel, or a comparable product.

3. Resilient Sound Isolation Clips: "IsoMax" resilient sound isolation clips as manufactured by Kinetics Noise Control.

4. "C-H," "CT," or "I" Type Stud: 1-1/2" x 2-1/2", 4" or 6" wide (to suit detail) galvanized steel. Use for shaft wall construction; gauge and size as required to meet deflection limits given herein.

   a. Product: ClarkDietrich; CT Stud, or a comparable product.

5. Double "E" Type Stud or "J" Track with Holding Tabs: 1" x 2-1/2", 4" or 6" wide (to suit detail) galvanized steel. Use for shaft wall construction; gauge and size as required to meet deflection limits given herein.

   a. Product: ClarkDietrich; J-Ribbed Track, or a comparable product.

6. Continuous 16 gauge x 8" wide steel wall plate screwed to studs as required for support of railings, toilet partitions and other items supported on drywall partitions and walls.

7. Isolated Wall Braces for Double Wall Assemblies: Provide IsoMax Mainstay System with Unibrace-L Bracket by Kinetics Noise Control.

C. Suspended Ceiling and Fascia Supports

1. Main Runners: 1-1/2" steel channels, cold rolled at 0.475 lbs. per ft., rust-inhibitive paint finish.

2. Furring Members: Screw-type hat-shaped furring channels of 25 ga. zinc-coated steel; comply with ASTM C 645.

3. Hangers: Galvanized, 1" x 3/16" flat steel slats capable of supporting 5x calculated load supported.

4. Hanger Anchorages: Provide inserts, clips, bolts, screws and other devices applicable to the required method of structural anchorage for ceiling hangers. Size devices for 5x calculated load supported.

5. Furring Anchorages: 16 ga. galvanized wire ties, manufacturer's standard clips, bolts or screws as recommended by furring manufacturer.

6. Resilient Furring Channels: 1/2" deep, asymmetrical, 25 ga. steel sheet members designed to reduce sound transmission; provide "RC-1 PRO" resilient channel as manufactured by ClarkDietrich Building Systems, or approved equal.

7. Spring Isolation Hangers: Spring isolation hanger shall consist of free-standing, large-diameter, laterally-stabile steel springs in series with an elastomer-in-shear insert, assembled into a stamped or welded hanger bracket. Isolation hangers shall be selected for each specific application to comply with deflection requirements as indicated in the specifications. Provide "30N" as manufactured by Mason Industries, "SRH-2 Series A" as manufactured by Kinetic Noise Control, or approved equal.

D. Protective Coating: All cold-formed steel members shall have coating conforming to AISI S220; ASTM A 653, G60 or coating with equivalent corrosion resistance of ASTM A653/A653M, G60. Galvannealed products are not acceptable.

2.3 GYPSUM WALLBOARD TYPES

A. Gypsum Ceiling Board: 5/8" thick, sag-resistant, long edges tapered.

B. Fire-Rated Gypsum Wallboard: 5/8" thick "Sheetrock Firecode C" by USG, "Firecheck Type C" by Lafarge/Continental, "Gold Bond Fireshield" by National Gypsum, or "Type C" and "Type X" by CertainTeed Corp., 48" wide, in maximum lengths available to minimize end-to-end butt joints.

C. Water-Resistant Backing Board for Tile Finish: 1/2" thick, "DUROCK Glass Mat Tile Backerboard" by USG, "Dens-Shield Tile Backer Board" by Georgia Pacific or "DiamondBack Tile Backer" by CertainTeed Corp. Cover joints with a pressure sensitive woven glass fiber tape equal to Imperial Type P Tape.

D. Cement Board Backing for Tile Finish at Showers: 1/2" thick "Durock Tile Backer Board" by USG, "Wonder Board Lite" by Custom Building Products or approved equal.

E. Mold-Resistant Paperless Gypsum Wallboard: 5/8" thick, 48" wide "DensArmour Plus" and "DensArmour Plus Fireguard C" by Georgia Pacific, or equal by National Gypsum, USG or approved equal that has a rating of 10 per ASTM D 3273 with core that meets ASTM C 1396, Section 6 or ASTM C 1658.

F. Moisture/Mold-Resistant Gypsum Wallboard (at areas not receiving tile) (at all exterior walls , kitchens, restrooms, shower areas, janitor closets and wet areas): 5/8" thick "Mold Tough," "Mold Tough FR," by U.S. Gypsum, "DensArmor Plus" by Georgia Pacific, "Mold Defense" and/or "Mold Defense Type X" by Lafarge/Continental, or "Gold Bond EXP Interior Extreme Gypsum Board" by National Gypsum, 48" wide, in maximum lengths available to minimize end-to-end butt joints.

1. Board must have a rating of 10 per ASTM D 3273 with a core that meets ASTM C 1396, Section 6 or ASTM C 1658.

G. Mold-Resistant Shaft Wall Liner: Solid gypsum board liner for shaft wall construction, 1" thick, 24" wide, as required to suit condition, by standard lengths as required, beveled edges. Provide "Mold Tough Liner Panel" by USG, "DensGlass Ultra Shaft Guard" by Georgia Pacific, "Mold Defense Shaftliner Type X" and/or "Weather Defense Shaftliner Type X" by La Farge/Continental, "Gold Bond Brand Fireshield Shaft Liner XP" or "Gold Bond Brand EXP Extended Exposure Shaft Liner" by National Gypsum, or "M2Tech Shaftliner" by CertainTeed Corp.

1. Liner board must have a rating 10 per ASTM D 3273 with a core that meets ASTM C 1396 Section 6.

H. Acoustically-Enhanced Gypsum Board: Provide "QuietRock 530" by Quiet Solution, with STC of 52-74 per ASTM E 90, and conforming to ASTM C 1396. Multilayer product constructed of two layers of gypsum board sandwiching a Type X core.

2.4 ACCESSORIES

A. Acoustical Insulation: Paper-less, non-combustible, semi-rigid mineral fiber mat, thickness as indicated on drawings and as required to achieve STC rating indicated, in walls (unless otherwise indicated), 3 lb./cu. ft. maximum density; Thermafiber "Thermafiber SAFB," Rockwool "Rockwool AFB" or approved equal.

B. Fasteners for Wallboard: USG Brand Screws; Type S Bugle Head for fastening wallboard to lighter gauge interior metal framing (up to 20 ga.). Type S-12 Bugle Head for fastening wallboard to heavier gauge interior metal framing (20 ga. to 12 ga.); Type S and Type S-12 Pan Head for attaching metal studs to door frames and runners; and Type G Bugle Head for fastening wallboard to wallboard. Lengths specified below under "Part 3 - Execution" Articles and as recommended by drywall manufacturer.

C. Laminating Adhesive: "Sheetrock Brand Joint Compound."

D. Metal Trim - Corner Beads: For 90 degree external corners, provide ClarkDietrich "103 Deluxe Corner Bead (CBU)" or "103 Dur-A-Bead" by USG, 26 U.S. Std. ga. galvanized steel, 1-1/4" x 1-1/4".

E. Metal Trim - Edge Beads: "Sheetrock Brand Paper Faced Metal Bead and Trim."

F. Partition/Concrete Ceiling Trim: Trim-Tex Super Seal Tear Away or approved equal.

G. Metal Trim Treatment Materials and Joint Treatment Materials for Gypsum Drywall Boards: Paper tape for joint reinforcing; Setting Type (Durabond 90) or Lightweight Setting Type Joint Compound for taping and topping; and Ready Mix Compound for finishing.

1. For mold-resistant drywall, water-resistant drywall, and tile backer board, use glass mesh tape with setting joint compound that is rated 10 when tested in accordance with ASTM D 3273 and evaluated in accordance with ASTM D 3274. Acceptable joint compound is "Rapid Set One Pass" made by CTS Cement Manufacturing Corp. or "Rapid Joint" manufactured by Lafarge North America or approved equal meeting standards noted herein.

H. Control Joints: ClarkDietrich; #093 Control Joint or No. 0.093 by USG.

I. Acoustical Sealant: USG "Acoustical Sealant" or "Tremco Acoustical Caulking" of Tremco Mfg. Co., "MasterSeal NP520" by BASF or approved equal.

J. Neoprene Gaskets: Conform to ASTM D 1056.

K. Aluminum Reveal Trim: Extruded accessories of profiles indicated. Provide products of Gordon Inc., Pittcon Industries, or approved equal, fabricated of 0.062" thick aluminum sheet, mill finish, of alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where gypsum drywall is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Install drywall work in accordance with drywall manufacturer's printed instructions and as indicated on drawings and specified herein.

2. All metal framing for drywall partitions shall extend from floor to underside of structural deck above. Provide for vertical deflection with positive mechanical connections of framing members to structure.

3. Provide concealed reinforcement, 16 ga. thick by eight (8) inches wide or as detailed or as recommended by manufacturer, for attachment of railings, toilet partitions, and other items to be

supported on the partitions which cannot be attached to the metal framing members. Concealed reinforcement shall span between metal studs and be attached thereto using two (2) self-tapping pan head screws at each stud.

a. Back of drywall shall be scored or notched to prevent bulging out where reinforcement plate occurs.

4. All gypsum board layers must be installed with overlapping seams.

B. Fire-Rated Assemblies: Install fire-rated assemblies in accordance with requirements of authorities having jurisdiction, Underwriters' Laboratories and test results obtained and published by the drywall manufacturer, for the fire-rated drywall assembly types indicated on the drawings.

C. Acoustical Assemblies: Install acoustically-rated assemblies to achieve a minimum STC as noted on drawings, in accordance with test results obtained and published by the drywall manufacturer, for the drywall assembly type indicated on the drawings.

1. All full-height partitions shall incorporate insulation and conform to USG's recommended details for acoustical partitions and recommended application details for acoustical sealant.

a. Electrical and service outlets for adjacent rooms shall be positioned a minimum 16".
b. No drywall layers shall be continuous past a demising partition.
c. Demising partitions shall penetrate through perimeter fascia to the base building construction, such as column enclosures, etc.
d. Provide continuous acoustical (non-hardening) caulking beads on each side of the top and bottom stud runner at the three-way intersection between the runner, floor and drywall.
e. Provide acoustical caulking to close gaps between service outlets (electrical, telephone, data, etc.) and drywall.
f. Multiple layers of drywall shall be applied with joints staggered at least 16" relative to one another.
g. Wall penetrations wider than 24" to be framed out by metal studs, otherwise to be between full height studs. The framing shall maintain less than a 2-inch gap around ductwork or other service penetrating the wall.
h. Penetrations through sound-critical partitions (ducts, pipes, conduit, cable trays, etc.) shall be handled as follows:
    1). Gaps greater than 2" require drywall patching from both sides, carefully cut our around penetrating elements. Batt insulation shall be packed around penetrating elements within the area of the penetration.
    2). Gaps of 1 inch or more shall be packed with fiberglass insulation and filled from each side with heavy-density putty such as Nelson FSP or CLK Sealant, J. M. Clipper "Duxseal," 3M "Moldable Putty." Fire ratings of materials shall be verified by others.
    3). Gaps less than or equal to 1/4-inch shall be caulked with acoustical sealant or similar non-hardening compound.
    1). Gaps from 1/4-inch up to 1-inch shall be packed with compressed backer rod with acoustical sealant or similar non-hardening compound.
    2). Cable trays shall be packed tightly with heavy-density putty, as above, once cables are pulled.
i. Return air transfer and pathways shall be coordinated with mechanical engineers.
j. Provide all details and materials as required by drywall manufacturer to achieve laboratory Sound Transmission Class (STC) ratings.
k. Acoustically-rated partitions must extend to exterior masonry. Coordinate with thermal insulation, caulk between gypsum board and insulation.

D. Sealant

1. Install continuous acoustical sealant bead at top and bottom edges of wallboard where indicated or required for sound rating as wallboard is installed, and between metal trim edge beads and abutting construction.

2. Install acoustical sealant in 1/8" wide vertical control joints within the length of the wall or partitions, and in all other joints, specified below under "Control Joints." Install bead of acoustical sealant around electric switch and outlet boxes, piping, ducts, and around any other penetration in the wallboard; place sealant bead between penetrations and edge of wallboard.

3. Where sealant is exposed to view, protect adjacent surfaces from damage and from sealant material, and tool sealant flush with and in same plane as wallboard surface. Sealant beads shall be 1/4" to 3/8" diameter.

E. Wallboard Application

1. Do not install wallboard panels until steel door frames are in place; coordinate work with Section 081113, "Steel Doors and Frames."

2. See drawings for all board types. Use fire-rated wallboard for fire-rated assemblies. Use sag-resistant board for ceilings. Use water-resistant wallboard where indicated on drawings and where wallboard would be subject to moisture. Install water-resistant wallboard in full, large sheets (no scraps) to limit number of butt joints.

3. Apply wallboard with long dimension parallel to stud framing members, and with abutting edges occurring over stud flanges.

4. Install wallboard for partitions from floor to underside of structure above and secure rigidly in place by screw attachment, unless otherwise indicated.

5. Provide "Thermafiber" safing insulation meeting standards of Section 078413 at flutes of metal deck where partitions carry up to bottom of metal deck.

6. Neatly cut wallboard to fit around outlets, switch boxes, framed openings, piping, ducts, and other items which penetrate wallboard; fill gaps with acoustic sealant.

7. Where wallboard is to be applied to curved surfaces, dampen wallboard on back side as required to obtain required curve. Finish surface shall present smooth, even curve without fluting or other imperfections.

8. Screw fasten wallboard with power-driven electric screw driver, screw heads to slightly depress surface of wallboard without cutting paper, screws not closer than 3/8" from ends and edges of wallboard.

9. Where studs are doubled-up, screw fasten wallboard to both studs in a staggered pattern.

F. Cementitious Backer Board

1. General: Furnish cementitious backer board in maximum available lengths. Install horizontally, with end joints over framing members.

2. Fastening: Secure cementitious backer board to each framing member with screws spaced not more than 12 inches on center and not closer than 1/2" from the edge. Install screws with a conventional screw gun so that the screw heads are flush with the surface of the board.

3. Joint Treatment: Fill space between edge of backer and receptor with dry-set Portland cement or latex-Portland cement mortar. Fill all horizontal and vertical joints and corners with dry-set Portland cement or latex-Portland cement mortar. Apply fiberglass tape over joints and corners and embed with same mortar.

G. Metal Trim: Install and mechanically secure in accordance with manufacturer's instructions; and finish with three (3) coats of joint compound, feathered and finish sanded smooth with adjacent wallboard surface, in accordance with manufacturer's instructions.

1. Corner Beads: Install specified corner beads in single lengths at all external corners, unless corner lengths exceed standard stock lengths.

2. Edge Beads: Install specified edge beads in single lengths at all terminating edges of wallboard exposed to view, where edges abut dissimilar materials, where edges would be exposed to view, and elsewhere where shown on drawings. Where indicated on drawings, seal joint between metal edge bead and adjoining surface with specified gasket, 1/8" wide minimum and set back 1/8" from face of wallboard, unless other size and profile indicated on drawings.

3. Casing beads shall be set in long lengths, neatly butted at joints. Provide casing beads at juncture of board and vertical surfaces and at exposed perimeters.

H. Control Joint Locations: Gypsum board surfaces shall be isolated with control joints where:

1. Ceiling abuts a structural element, dissimilar wall or other vertical penetration.

2. Construction changes within the plane of the partition or ceiling.

3. Shown on approved shop drawings.

4. Ceiling dimensions exceed thirty (30) feet in either direction.

5. Wings of "L," "U," and "T" shaped ceiling areas are joined.

6. Expansion or control joints occur in the structural elements of the building.

7. Shaft wall runs exceed 30' without interruption.

8. Partition or furring abuts a structural element or dissimilar wall or ceiling.

9. Partition or furring runs exceed 30' without interruption.

10. Where control joints are required, ceiling height door frames may be used as control joints. Less than ceiling height frames shall have control joints extending to the ceiling from both corners.

I. Joint Treatment and Spackling

1. Joints between face wallboards in the same plane, joints at internal corners of intersecting partitions and joints at internal corners of intersections between ceilings and walls or partitions shall be filled with joint compound.

2. Screw heads and other depressions shall be filled with joint compound. Joint compound shall be applied in three (3) coats, feathered and finish surface sanded smooth with adjacent wallboard surface, in accordance with manufacturer's instructions. Treatment of joints and screw heads with joint compound is also required where wallboard will be covered by finish materials which require a smooth surface, such as vinyl wall coverings.

3.3 FURRED WALLS AND PARTITIONS

A. Use specified metal furring channels. Run metal furring channel framing members vertically, space sixteen (16) inches o.c. maximum. Fasten furring channels to concrete or masonry surfaces with power-driven fasteners or concrete stub nails spaced sixteen (16) inches o.c. maximum through alternate wing flanges (staggered) of furring channel. Furring channels shall be shimmed as necessary to provide a plumb and level backing for wallboard. At inside of exterior walls, an asphalt felt protection strip shall be installed between each furring channel and the wall. Furring channel and splices shall be provided by nesting channels at least eight (8) inches and securely anchoring to concrete or masonry with two (2) fasteners in each wing.

B. Wallboard Installation: Same as specified under Article 3.4 - "Metal Stud Partitions."

3.4 METAL STUD PARTITIONS

A. Unless otherwise noted, steel framing members shall be installed in accordance with ASTM C 754.

B. Runner Installation: Use channel type. Align accurately at floor according to partition layout. Anchor runners securely sixteen (16) inches o.c. maximum with power-driven anchors to floor slab, with power-driven anchors to structural slab above. See "Stud Installation" below for runners over heads of metal door frames. Where required, carefully remove sprayed-on fireproofing to allow partition to be properly installed.

C. Stud Installation

1. Use channel type, positioned vertically in runners, spaced as noted on drawings, but not more than sixteen (16) inches o.c.

2. Anchor studs to floor runners with screw fasteners. Provide snap-in or slotted hole slip joint bolt connections of studs to ceiling runners leaving space for movement. Anchor studs at partition intersections, partition corners and where partition abuts other construction to floor and ceiling runners with sheet metal screws through each stud flange and runner flange.

3. Connection at ceiling runner for non-rated partitions shall be snap-in or slotted hole slip joint bolt connection that shall allow for movement. Seal studs abutting other construction with 1/8" thick neoprene gasket continuously between stud and abutting construction.

4. Connections for fire rated partitions at ceiling runners shall conform to UL Design #2079.

5. Install metal stud horizontal bracing wherever vertical studs are cut or wallboard is cut for passage of pipes, ducts or other penetrations, and anchor horizontal bracing to vertical studs with sheet metal screws.

6. At jambs of door frames and borrowed light frames, install doubled-up studs (not back to back) from floor to underside of structural deck, and securely anchor studs to jamb anchors of frames and to runners with screws. Provide cross braces from hollow metal frames to underside of slab.

7. Over heads of door frames, install cut-to-length section of runner with flanges slit and web bent to allow flanges to overlap adjacent vertical studs, and securely anchor runner to adjacent vertical studs with sheet metal screws. Install cut-to-length vertical studs from runner (over heads of door frame) to ceiling runner sixteen (16) inches maximum o.c. and at vertical joints of wallboard, and securely anchor studs to runners with sheet metal screws.

8. At control joints, in field of partition, install double-up studs (back to back) from floor to ceiling runner, with 1/4" thick continuous compressible gasket between studs. When necessary, splice studs with eight (8) inches minimum nested laps and attach flanges together with two (2) sheet metal screws in each flange. All screws shall be self-tapping sheet metal screws.

D. Runners and Studs at Chase Wall: As specified above for "Runners" and "Studs" and as specified herein. Chase walls shall have either a single or double row of floor and ceiling runners with metal studs sixteen (16) inches o.c. maximum and positioned vertically in the runners so that the studs are opposite each other in pairs with the flanges pointing in the same direction. Anchor all studs to runner flanges with sheet metal screws through each stud flange and runner flange following requirements of paragraph 3.4, B. Provide cross bracing between the rows of studs by attaching runner channels or studs set full width of chase attached to vertical studs with one self-tapping screw at each end. Space cross bracing not over thirty-six (36) inches o.c. vertically.

E. Wallboard Installation - Single Layer Application (Screw Attached)

1. Install wallboard with long dimension parallel to framing member and with abutting edge joints over web of framing member. Install wallboard with long dimension perpendicular to framing members above and below openings in drywall extending to second stud at each side of opening. Joints on opposite sides of wall shall be arranged so as to occur on different studs.

2. Boards shall be fastened securely to metal studs with screws as specified. Where a free end occurs between studs, back blocking shall be required. Center abutting ends over studs. Correct work as necessary so that faces of boards are flush, smooth, true.

3. Wallboard screws shall be applied with an electric screw gun. Screws shall be driven not less than 3/8" from ends or edges of board to provide uniform dimple not over 1/32" deep. Screws shall be spaced twelve (12) inches o.c. in the field of the board and 8" o.c. staggered along the abutting edges.

4. All ends and edges of wallboard shall occur over screwing members (studs or furring channels). Boards shall be brought into contact but shall not be forced into place. Where ends or edges abut, they shall be staggered. Joints on opposite sides of a partition shall be so arranged as to occur on different studs.

5. At locations where piping receptacles, conduit, switches, etc., penetrate drywall partitions, provide non-drying sealant and an approved sealant stop at cut board locations inside partition.

F. Wallboard Installation - Double-Layer Application

1. General: See drawings for wallboard partition types required.

2. First Layer (Screw Attached): Install as described above for single layer application.

3. Second Layer (Screw Attached): Screw attach second layer, unless laminating method of attachment indicated on drawings or necessary to obtain required sound rating or fire rating. Install wallboard vertically with vertical joints offset thirty-two (32) inches from first layer joints and staggered on opposite sides of wall. Attach wallboard with 1-5/8" screws sixteen (16) inches o.c. along vertical joints and sixteen (16) inches o.c. in the field of the wallboard. Screw through first layer into metal framing members.

4. Second Layer (Laminated): Install wallboard vertically. Stagger joints of second layer from first layer joints. Laminate second layer with specified laminating adhesive in beads or strips running continuously from floor to ceiling in accordance with manufacturer's instructions. After laminating, screw wallboard to framing members with 1-5/8" screws, spaced twelve (12) inches o.c. around perimeter of wallboard.

G. Wallboard Installation - Laminated Application: Where laminated wallboard is indicated, use specified laminating adhesive, install wallboard vertically and maintain tolerances as specified for screw attached wallboard.

H. Insulation Installation: Install where indicated on drawings. Place blanket tightly between studs.

I. Deflection of Structure Above: To allow for possible deflection of structure above partitions, provide top runners for non-rated partitions with 1-1/4" minimum flanges and do not screw studs or drywall to top runner. Where positive anchorage of studs to top runner is required, anchorage device shall be by means of slotted hole (in clip connection with screw attachment to web of steel through bushings located in slots of clips), or other anchorage device approved by Architect.

J. Control Joints

1. Leave a 1/2" continuous opening between gypsum boards for insertion of surface mounted joint.

2. Back by double framing members.

3. Attach control joint to face layer with 9/16" galvanized staples six (6) inches o.c. at both flanges along entire length of joint.

4. Provide two (2) inch wide gypsum panel strip or other adequate seal behind control joint in fire rated partitions and partitions with safing insulation.

3.5 DRYWALL FASCIAS AND CEILINGS

A. Furnish and install inserts, hanger clips and similar devices in coordination with other work.

B. Secure hangers to inserts and clips. Clamp or bolt hangers to main runners.

C. Space main runners 4'-0" o.c. and space hangers 4'-0" o.c. along runners, except as otherwise shown.

D. Level main runners to a tolerance of 1/4" in 12'-0", measured both lengthwise on each runner and transversely between parallel runners.

E. Metal Furring Channels: Space sixteen (16) inches o.c. maximum. Attach to 1-1/2" main runner channels with furring channel clips (on alternate sides of main runner channels). Furring channels shall not be let into or come in contact with abutting masonry walls. End splices shall be provided by nesting furring channels no less than eight (8) inches and securely wire tying. At any openings that interrupt the furring channels, install additional cross reinforcing to restore lateral stability.

F. Mechanical accessories, hangers, splices, runner channels and other members used in suspension system shall be of metal, zinc coated, or coated with rust inhibitive paint, of suitable design and of adequate strength to support units securely without sagging, and such as to bring unit faces to finished indicated lines and levels.

1. Provide special furring where ducts are over two (2) feet wide.

G. Apply board with its long dimension at right angles to channels. Locate board butt joints over center of furring channels. Attach board with one (1) inch self-drilling drywall screws twelve (12) inches o.c. in field of board at each furring channel; eight (8) inches o.c. at butt joints located not less than 3/8" from edges.

3.6 SHAFT WALLS

A. Runner Installation: Use "J" metal runners at floor and ceiling, with the short leg toward finish side of wall. Securely attach runners to structural supports with power-driven fasteners at both ends and twenty-four (24) inches o.c.

B. Shaft Wall Liner: Cut shaft wall liner panels one (1) inch less from floor to ceiling height and erect vertically between J-runners.

C. C-H Studs: Cut metal studs 3/8" to not more than 1/2" less than floor to ceiling height and install between shaft wall liner panels so that panels are fitted snugly into the one (1) inch wide "H," "T," or "I" portion of the stud. Space studs twenty-four (24) inches o.c., unless otherwise indicated on drawings. Install full-length steel E-Studs or J-runners vertically at T-intersections, corners, door jambs, and columns. Install full length E-Studs or J-runners over shaft wall liner both sides of closure panels. Frame openings cut within a liner panel with J-Runner around perimeter. For openings, frame with vertical E-Stud or J-runner at edges, horizontal runner at head and sill, and reinforcing as shown on the drawings. Suitably frame all openings to maintain structural support for wall. Install floor-to-ceiling steel E-Studs or J-runners each side of elevator door frames to act as strut-studs. Attach strut-stud to floor and ceiling runners with two (2) 3/8" Type S screws, space twelve (12) inches o.c. Over metal doors, install a cut to length section of runner and attach to strut-studs with clip angles and 3/8" Type S Screws space twelve (12) inches o.c.

D. Wallboard Installation - Double Layer Installation: Erect gypsum wallboard base layer vertically or horizontally to meet fire rating on one side of studs with end joints staggered. Fasten base layer panels to studs with one (1) inch Type S screws twenty-four (24) inches o.c. Caulk perimeter of base layer panels. Apply gypsum wallboard face layer vertically over base layer with joints staggered and attached with 1-5/8" Type S screws staggered from those in base, spaced eight (8) inches o.c. and driven into studs.

E. Wallboard Installation (Where Both Sides of Shaft Wall are Finished): Apply gypsum wallboard face layers vertically both sides of studs. Stagger joints on opposite partition sides. Fasten panels with one (1) inch or two (2) inches Type S screws spaced eight (8) inches o.c. in field and along edges into studs.

F. Cants: Provide one (1) inch thick shaft wall liner, cut to suit condition, at beams and other projections wider than two (2) inches in elevator shafts. Cants shall slope seventy-five (75) degrees from the horizontal. Screw attach shaft wall liner to the vertical metal studs.

G. Support elevator hoistway door frames independently of drywall shaft framing system or reinforce system in accordance with system manufacturer's instructions.

H. Where handrails are indicated for direct attachment to drywall shaft system, provide not less than a sixteen (16) ga. x eight (8) inches wide galvanized steel reinforcement strip, accurately positioned and secured to studs and concealed behind not less than one 1/2" thick course of gypsum board in the system.

I. Integrate stair hanger rods with drywall shaft system by locating cavity of system as required to enclose rods.

3.7 ERECTION AT COLUMN ENCLOSURES

A. Metal furring supports shall be provided under work of this Section, and shall be cut to lengths as necessary for tight fit such that spacing is not more than sixteen (16) inches o.c.

B. Board shall be fastened securely to supports with screws as specified. Place boards in position with minimum number of joints. Where free ends occur between supports, back-blocking or furring shall be required. Center abutting ends over supports. Correct work as necessary so that faces of boards are flush, smooth and true. Provide clips or cross furring for attachment as required.

C. All layers shall be screw attached to furring.

D. When column finish called for on drawings to be in the same plane as drywall finish layer, maintain even, level plane.

3.8 FINISHING

A. Taping: A thin, uniform layer of compound shall be applied to all joints and angles to be reinforced. Reinforcing tape shall be applied immediately, centered over the joint, seated into the compound. A skim

coat shall follow immediately but shall not function as a fill or second coat. Tape shall be properly folded and embedded in all angles to provide a true angle.

B. Filling: After initial coat of compound has hardened, additional compound shall be applied, filling the board taper flush with the surface. The fill coat shall cover the tape and feather out slightly beyond the tape. On joints with no taper, the fill coat shall cover the tape and feather out at least four (4) inches on either side of the tape. No fill coat is necessary on interior angles.

C. After compound has hardened, a finishing coat of compound shall be spread evenly over and extending slightly beyond the fill coat on all joints and feathered to a smooth, uniform finish. Over tapered edges, the finished joint shall not protrude beyond the plane of the surface. All taped angles shall receive a finish coat to cover the tape and taping compound and provide a true angle. Where necessary, sanding shall be done between coats and following the final application of compound to provide a smooth surface, ready for painting.

D. Fastener Depressions: Compound shall be applied to all fastener depressions followed, when hardened by at least two (2) coats of compound, leaving all depressions level with the plane of the surface.

E. Finishing Beads and Trim: Compound shall be applied to all bead and trim and shall be feathered out from the ground to the plane of the surface. When hardened, this shall be followed by two (2) coats of compound each extending slightly beyond the previous coat. The finish coat shall be feathered from the ground to the plane of the surface and sanded as necessary to provide a flat, smooth surface ready for decoration.

F. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840 and GA-214 of the Gypsum Association.

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

2. Level 2: Panels that are a substrate for tile, and where indicated.

3. Level 4: Level of finish for surfaces exposed to view shall conform to Level 4, except as noted below.

4. Level 5: Level of finish for Snug L2 mural walls shall conform to Level 5.

a. Skim Coat: For final coat of Level 5 finish, use setting type, sandable topping compound.

G. Drywall construction with defects of such character which will mar appearance of finished work, or which is otherwise defective, will be rejected and shall be removed and replaced at no expense to the Owner.

3.9 CLEANING AND ADJUSTMENT

A. At the completion of installation of the work, all rubbish shall be removed from the building leaving floors broom clean. Excess material, scaffolding, tools and other equipment shall be removed from the building.

B. Work shall be left in clean condition ready for painting or wall covering. All work shall be as approved by Architect.

C. Cutting and Repairing: Include all cutting, fitting and repairing of the work included herein in connection with all mechanical trades and all other trades which come in conjunction with any part of the work and leave all work complete and perfect after all trades have completed their work.

3.10 PROTECTION OF WORK

A. Installer shall advise Contractor of required procedures for protecting drywall work from damage and deterioration during remainder of construction period.

END OF SECTION

SECTION 093013

CERAMIC TILING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the ceramic tiling work as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Ceramic and porcelain floor tile.
2. Ceramic and porcelain wall tile and base.
3. Slate tile.
4. Stone saddles.
5. Setting beds, grout and sealant.
6. Waterproofing membrane.
7. Acoustical underlayment.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Unit Masonry - Section 042000.

C. Gypsum Drywall - Section 092900.

D. Quarry Tiling - Section 093016.

1.4 REFERENCES

A. ANSI A108 Series/A118 Series - American National Standards for Installation of Ceramic Tile.

B. ANSI A136.1 - American National Standards for Organic Adhesives for Installation of Ceramic Tile.

C. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.

D. ASTM C 150 - Standard Specification for Portland Cement.

E. TCNA - Handbook for Ceramic, Glass and Stone Tile Installation; Tile Council of North America.

F. ISO 13007 - International Standards Organization; Classification for Grout and Adhesives.

G. Large Format Tile (LFT): Tile 15" or larger in any direction and/or 144 sq. in. in size.

H. Stone Tile: Conform to requirements of MIA (Marble Institute of America) Dimension Stone Design Manual.

1.5 QUALITY ASSURANCE

A. Qualifications of Installers: For cutting, installing and grouting of ceramic tile, use only thoroughly trained and experienced journeyman tile setters who are completely familiar with the requirements of this work, and the recommendations contained in the referenced standards, and the installers are Certified Ceramic Tile Installer (CTI) through the Ceramic Tile Education Foundation (CTEF) or Tile Installer Thin Set Standards (ITS) verification through the University of Ceramic Tile and Stone.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with the following:

1. Manufacture all ceramic tile in accordance with Standard Grade Requirements of ANSI A-137.1.

2. Install all ceramic tile in accordance with the recommendations contained in "Tile Council of North America Handbook for Ceramic, Glass, and Stone Tile Installation (TCNA)," latest edition.

3. Stone tiles shall conform to the requirements of ASTM C 1242.

C. All surfaces shall have a minimum wet DCOF AcuTest value of 0.42 and tested per ANSI A326.3 Dynamic Coefficient of Friction of Hard Surface Flooring Materials.

1.6 SUBMITTALS

A. Samples

1. Before any ceramic tile is delivered to the job site, submit to the Architect sample panels, approx. 12" x 12", mounted on hardboard back-up with selected grout color for each color and pattern of ceramic tile and grout specified.

2. Submit 6" length of stone saddles.

3. Submit 12" x 12" samples of waterproofing membrane.

B. Master Grade Certificates: Prior to opening ceramic tile containers, submit to the Architect a Master Grade Certificate, signed by an officer of the firm manufacturing the ceramic tile used, and issued when the shipment is made, stating the grade, kind of tile, identification marks for tile containers, and the name and location of the project.

C. Mock-Ups

1. At an area on the site where approved by the Architect, provide a mock-up ceramic tile installation.

a. Make the mock-up approximately 36" x 36" in dimension.
b. Provide one mock-up for each type, class, and color of installation required under this Section.
c. The mock-ups may be used as part of the Work, and may be included in the finished Work when so approved by the Architect.
d. Revise as necessary to secure the Architect's approval.

2. The mock-ups, when approved by the Architect, will be used as datum for comparison with the remainder of the work of this Section for the purposes of acceptance or rejection.

3. If the mock-up panels are not permitted to be part of the finished Work, completely demolish and remove them from the job site upon completion and acceptance of the work of this Section.

1.7 PRODUCT HANDLING

A. Delivery and Storage

1. Deliver all materials of this Section to the job site in their original unopened containers with all labels intact and legible at time of use.

2. Store all materials under cover in a manner to prevent damage and contamination; store only the specified materials at the job site.

B. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of all other trades.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

C. Maintain temperatures at not less than 50 deg. F. in tiled areas during installation and for 7 days after completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS OF TILE

A. Provide tile as indicated on the Materials List on the drawings, or approved equal meeting these specifications. The Architect reserves the right to pick tile from any price group.

2.2 TRIM AND SPECIAL SHAPES

A. Tile Trim: Provide external and internal corners, trim shapes at openings, and all other trim and special shapes to match the tile specified herein, as required by field conditions and drawing details.

B. Provide anodized aluminum trim at exposed edges of tile, tile corners and exposed edges of tile bases, to match tile dimensions specified herein and as required by field conditions.

1. Corner Trim: Schluter "Fintec."

2. Edge Trim: Schluter "Schiene."

2.3 STONE SADDLES

A. Provide sound stone of variety indicated on the Materials List on the drawings, minimum 3/4" thick, with an abrasive hardness of not less than 10.0, when tested in accordance with ASTM C 241. Cut saddle to fit jamb profile, honed finish.

2.4 SETTING BEDS AND GROUT

A. Portland Cement: ASTM C 150, Type 1.

B. Hydrated Lime: ASTM C 207, Type S.

C. Sand: ASTM C 144, clean and graded natural sand.

D. Reinforcing for Mud Set Systems: 2" x 2" x 16/16 ga. welded wire mesh.

E. Latex Admixture for Mortar Bed

1. MAPEI, Planicrete AC, blended with a 3:1 site mix.

2. Laticrete 333.

3. Pro Spec; Acrylic Additive.

4. Custom Building Products; Custom Crete Thin Set Additive.

F. Latex-Portland Cement Bond Coat, complying with ANSI A118.4 and ISO 13007, C2ES2P2 with minimum compressive strength of 400 psi.

1. MAPEI, Keralastic System thin set mortar, consisting of Kerabond dry-set mortar and Keralastic latex admixture.

2. Laticrete; 211 dry-set mortar and 4237 latex admixture.

3. Pro Spec; Permalastic System consisting of Permalastic Dryset Mortar and Permalastic Admixture

4. Custom Building Products; Pro-Lite.

G. Improved Modified Cement Mortars: For use with LFT and stone tile, complying with ANSI 118.15 and ISO 13007, CSES2PS.

1. Custom Building Products; Mega-Lite Crack Prevention Mortar (650-725 psi).

2. Laticrete; TriLite or 254 Platinum.

3. Mapei; Kerabond T Keralastic (400-600 psi).

4. Pro Spec; StayFlex 590 (460 psi).

H. Wall and Base Tile

1. Over cement board, use a Latex Portland cement mortar bond coat, MAPEI, Kerabond/Keralastic System, Custom Mega Flex or equal by Laticrete or Pro Spec, conforming to ANSI A118.4, ISO 13007-C2ES2P2, and TCA Detail W-244; coat back of board with waterproof membrane as specified below.

2. Over glass mat water resistant gypsum backer board, use a Latex Portland cement mortar bond coat, MAPEI, Kerabond/Keralastic System, conforming to ANSI A118.4, ISO 13007-C2ES2P2, and TCA Detail W-245.

I. Floor Tile and Stone Saddle - Mud Set: Set floor tile and stone saddle using Portland Cement mortar setting bed conforming to ANSI A108.1A and latex modified Portland cement bond coat. Basis of Design: Mapei, Kerabond/Keralastic System, conforming to ANSI A118.4, ISO 13007-C2ES2P2, and TCA Detail F-112.

1. For installation of LFT and Stone Tile, Improved Modified Cement Mortars and medium bed; Basis of Design: Custom Building Products, MegaLite Crack Prevention Medium Bed Mortar conforming to ANSI 118.15, ISO 13007-C2ES2P2.

J. Floor Tile and Stone Saddle - Thin Set: Set floor tile and stone saddle using latex modified Portland Cement mortar, Basis of Design, Mapei, Kerabond/Keralastic System, conforming to ANSI A118.4, ISO 13007-C2ES2P2, and TCA Detail F-113.

1. For installation of LFT and Stone Tile, Improved Modified Cement Mortars and medium bed; Basis of Design: Custom Building Products, MegaLite Crack Prevention Medium Bed Mortar conforming to ANSI 118.15, ISO 13007-C2ES2P2.

K. Floor Tile and Stone Saddle - Thin Set over Waterproof Setting Bed: Set floor tile and stone saddle using thin set latex Portland cement bond coat, Basis of Design: Mapei, Kerabond/Keralastic System, conforming to ANSI A118.4, ISO 13007-C2ES2P2, and waterproofing membrane conforming to TCA Detail F-122/122A.

1. For installation of LFT and Stone Tile, Improved Modified Cement Mortars and medium bed; Basis of Design: Custom Building Products, MegaLite Crack Prevention Medium Bed Mortar conforming to ANSI 118.15, ISO 13007-C2ES2P2.

L. Waterproofing Membrane: Complying with ANSI A118.10 and ANSI A118.12; and having IAPMO certification as a shower pan liner; provide "Mapelastic AquaDefense" by Mapei with factory blended "Bio-Block" antimicrobial protection, "Laticrete 9235 with Mircoban" made by Laticrete International, ProSpec "B6000," Custom Building Products' "9240," or approved equal.

1. Reinforce membrane with polyester fabric.

2. At showers, provide chlorinated polyethylene (CPE) sheet confirming to ASTM D 4068, minimum 0.04" thick. Run waterproofing up full height of walls.

M. Showers: Comply with TCNA Detail B415 with waterproof membrane full height. Shower pan liner shall be Mapeguard WP 200 by Mapei or approved equal.

N. Water: Clean, fresh and suitable for drinking.

O. Grout: Complying with A118.7; and ISO 13007, CG2WAF; for grouting ceramic tile, provide a commercial Portland cement grout "Ultracolor Plus" (additive not required) made by Mapei, Laticrete "Permacolor," or approved equal; color as selected by the Architect. Add latex additive to grout made by same manufacturer as grout.

P. Physical Properties: The setting beds and grouts must meet the following physical requirements:

1. Compressive Strength: 3000 psi min.

2. Shear Bond Strength: 500 psi min.

3. Water Absorption: 4.0% max.

4. Service Rating (ASTM C 627): Extra Heavy Duty.

Q. Sealer: Seal all grout joints and all unglazed tile using "Sealer's Choice 15 Gold" as manufactured by Aqua Mix Inc., or approved equal.

R. Temporary Protective Coating: Either product indicated below that is applied in the tile manufacturer's factory and formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, applied hot, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg. F. per ASTM D 87.

2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

S. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.5 SEALANT

A. Joint Backing: Preformed, compressible, resilient, non-extruding, non-staining strips of foam neoprene, foam polyethylene, or other material recommended by sealant manufacturer.

B. Bond Breaker: Polyethylene tape, 3 mils thick, or other material recommended by sealant manufacturer.

C. Sealant Primer: Colorless, non-staining, or type to suit substrate surface, as recommended by sealant manufacturer.

D. Sealant: One-part silicone based sanitary sealant, conforming to ASTM C 920, Type S, Grade NS, Class 25. Sealant hardness upon full cure shall be between 20-30 Shore "A" Durometer. Color of sealant to blend with or match adjacent materials, and as selected by the Architect. Sealant shall be equivalent to 1700 Sanitary Sealant made by General Electric or approved equal.

2.6 ACOUSTICAL UNDERLAYMENT

A. Acoustical Mat: Provide a 15-mm thick, 40 durometer non-laminated, flat, resilient, single-ply rubber underlayment equal to "RST-15" as manufactured by Pliteq, or approved equal.

B. Perimeter Isolation Strip: Provide a 10-mm (3/8") thick, flat, resilient, single-ply re-bonded rubber strip equal to "GenieMat PMI-10" as manufactured by Pliteq, or approved equal.

C. Underlayment Adhesive: "GenieMat FAS" High Solid Acrylic-Urethane Adhesive by Pliteq, or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where ceramic tile is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 CONDITION OF SURFACES

A. Allowable Variations in Substrate Levels in Floors: + 1/8" in 10'-0" distance and 1/4" total max. variation from levels shown.

B. Grind or fill concrete and masonry substrates as required to comply with allowable variations.

C. Concrete substrates must meet ANSI A108.01 tolerances and surface textures in preparation for tile work. Coordinate with concrete trades.

3.3 PREPARATION

A. Coordinate the following with Section 033000:

1. Steel trowel and fine broom finish concrete slabs that are to receive ceramic tile. Cure concrete slabs that are to receive tile before tile application. Do not use liquid curing compounds or other

coatings that may prevent bonding of tile setting materials to slabs. Slab shall be dry at time of tile installation.

2. Tile floors with floor drains must have a slope to direction of ¼" per foot; coordinate this with concrete trades.

B. Etch concrete substrate as may be required to remove curing compounds or other substances that would interfere with proper bond of setting bed. Rinse with water to remove all traces of treatment.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at project site before installing.

D. Field Applied Temporary Protective Coating: Pre-coat tile with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.4 JOINTS IN TILE WORK

A. Joint Widths: As scheduled and per drawings.

B. Alignment: Wall, base and floor joints shall align through the field and trim. Direction and location of all joints as directed by Architect.

C. Movement Joints: Conform to TCA Detail EJ171. Locate where movement joints are in back-up material. Provide movement joint at joints between mop receptors and ceramic tile. Provide movement joint at all vertical internal joints of wall tile. Movement joints 1/8" wide in ceramic tile. Fill all movement joints with specified backing and sealant. Use bond breaker where sufficient space for joint backing does not exist.

1. Provide sealant between ceramic tile and plumbing fixtures, mirrors, pipes, countertops and other dissimilar materials penetrating or adjacent to ceramic tile.

3.5 INSTALLATION

A. Comply with the following installation standards:

1. Wall tile over cement board or glass mat backer board using dry set mortar with latex additive - ANSI A118.4 and ISO 13007, C2ES2P2.

2. Floor tile using full mud set mortar - ANSI A118.4, A228.15, and ISO 13007, C2ES2P2.

3. Floor tile using dry set mortar with latex additive - ANSI A118.4, A118.15, and ISO 13007, C2ES2P2.

4. Floor tile over waterproofing membrane - ANSI A118.4, 118.5, and ISO 13007, C2ES2P2.

B. Backs of tile must be cleaned before installation.

C. All setting beds and/or adhesives shall provide for an average contact area of not less than 95% coverage.

D. Allowable Variations in Finished Work: Do not exceed the following deviations from level and plumb, and from elevations, locations, slopes and alignment shown.

1. Floors: 1/8" in 10'-0" run, any direction; +/- 1/8" at any location; 1/32" offset at any location.

2. Walls: 1/8" in 8'-0" run, any direction; 1/8" at any location; offset at any location, 1/32".

3. Joints: +/- 1/32" joint width variation of any location; 1/16" in 3'-0" run deviation from plumb and true.

E. Waterproofing Membrane

1. Install the membrane in strict accordance with manufacturer's written recommendations.

2. Upon completion of work, test horizontal membrane for leaks by flood testing per ASTM D 5957. Inspect for leakage. Make necessary adjustments to stop all leakage and retest until watertight. If membrane is not immediately covered by another surface, provide protection until membrane is covered.

F. Handle, store, mix and apply setting and grouting materials in compliance with the manufacturer's instructions.

G. Extend tile work into recesses and under equipment and fixtures, to form a complete covering without interruptions. Terminate work neatly at obstructions, edges and corners without disruption of pattern or joint alignment.

H. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight, aligned joints. Fit tile closely to electrical outlets, piping and fixtures so that plates, collars, or covers overlap tile.

I. Lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are the same size. Lay out tile work and center tile fields both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths.

3.6 ACOUSTICAL UNDERLAYMENT

A. Install acoustical underlayment and perimeter isolation strips in accordance with the manufacturer's installation instructions.

B. In order to isolate the floor and break sound transmission path between floor and walls, install 1/4" thick, flat, resilient, single-ply re-bonded rubber perimeter isolation strip, "GenieMat PMI-10," or approved equal, at the base of the perimeter walls of the entire subfloor and around the perimeter of any protrusions through the installation. Tape or tack glue the perimeter isolation strip material.

C. Lay sound control mat under entire areas to be covered by tile flooring and firmly seat in adhesive as recommended by underlayment manufacturer. Allow adhesive to set up for approximately 45 minutes and apply mat in accordance with manufacturer's recommendations. Roll surfaces to insure total adhesion free of bubbling, lifting, etc. Reset areas not totally adhered.

3.7 INSTALLATION OF STONE SADDLES

A. Install stone saddles cut to profiles and sizes shown, accurately fitted to jambs, coped at stops, set in full bed of mortar herein specified, and with grouted edge joints as specified for floor tile.

3.8 CLEANING AND PROTECTION OF CERAMIC TILE

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use cleaners only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning to insure removal of all cleaning material.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. Apply coat of sealer to all grout joints and all unglazed tile.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings from tile surfaces.

E. Leave finished installation clean and free of cracked, chipped, broken, unbonded or otherwise defective tile work.

END OF SECTION

SECTION 093016

QUARRY TILING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the quarry tiling as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Quarry floor tile and base.

2. Setting beds, grout, sealant and waterproofing membrane.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Gypsum Drywall - Section 092900.

C. Ceramic Tiling - Section 093013.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: For cutting, installing and grouting of quarry tile, use only thoroughly trained and experienced journeyman tile setters who are completely familiar with the requirements of this work and the recommendations contained in the referenced standards and are TITC Certified.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with the following:

1. Manufacture all quarry tile in accordance with Standard Grade Requirements of ANSI A-137.1.

2. Install all quarry tile in accordance with the recommendations contained in Handbook for Ceramic, Glass and Stone Tile Installation of the Tile Council of North America, Inc., latest edition and ANSI A108/A118/A136.

1.5 SUBMITTALS

A. Samples: Before any quarry tile is delivered to the job site, submit to the Architect sample panels, approx. 12" x 12", mounted on hardboard back-up for each color and pattern of quarry tile specified.

B. Master Grade Certificates: Prior to opening quarry tile containers, submit to the Architect a Master Grade Certificate, signed by an officer of the firm manufacturing the tile used, and issued when the shipment is made, stating the grade, kind of tile, identification marks for tile containers, and the name and location of the project.

C. Submit independent test reports indicating that setting beds and grout conform to the physical requirements specified herein.

1.6 PRODUCT HANDLING

A. Delivery and Storage

1. Deliver all materials of this Section to the job site in their original unopened containers with all labels intact and legible at time of use.

2. Store all materials under cover in a manner to prevent damage and contamination; store only the specified materials at the job site.

B. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work of all other trades.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

C. Maintain temperatures at not less than fifty (50) degrees F in tiled areas during installation and for seven (7) days after completion.

PART 2 PRODUCTS

2.1 QUARRY TILE

A. Provide 6" x 6" quarry tile flooring as noted on the Materials List or approved equal.

B. Provide trim, cove base and special shapes as required for complete installation of same material, size, color and finish of field tile.

2.2 MORTAR BED, BOND COAT AND GROUT

A. All products shall be factory prepared; there shall be no on-site mixing of Portland cement and sand.

B. Portland Cement: ASTM C 150, Type 1.

C. Hydrated Lime: ASTM C 207, Type S.

D. Sand: ASTM C 144, clean and graded natural sand.

E. Reinforcing: 2" x 2" x 16/16 gauge galvanized welded wire mesh.

F. Latex Additive for Mortar Bed:

1. MAPEI, Planicrete AC.

2. Laticrete 333.

3. ProSpec – B710 Mortar Additive

4. Custom Flex Thin Set Additive.

G. Latex-Portland Cement Bond Coat:

1. MAPEI, Keralastic System consisting of Kerabond dry-set mortar and Keralastic latex admixture or

2. Laticrete, 211 dry-set mortar and 4237 latex admixture.

3. MAPEI, Granirapid System consisting of Granirapid Powder and Granirapid Liquid (for rapid setting requirements).

4. Laticrete, 211 dry-set mortar and 4237 latex admixture and 101 rapid setting admixture.

5. ProSpec Permalastic System consisting of Permalastic Dryset Mortar and Permalastic Admixture.

6. Custom Porcelain Tile Thin Set Mortar.

7. Custom Mega Lite R/S Crack Prevention Mortar.

H. Waterproofing Membrane (with Fabric):

1. MAPEI, Mapelastic 400.

2. Laticrete 9235.

3. ProSpec B6000.

4. Custom 9240.

I. Base Tile

1. Over drywall use ANSI A136.1-1967 Organic Adhesive for installation of Ceramic Tile, Type 1. Shear strength shall be 50 psi minimum. Adhesive primer as recommended by adhesive manufacturer. Manufacturer shall certify, in writing, that adhesive and primer used are proper types for the intended tile types and application. Conform to TCA Detail W-202.

2. Over masonry and concrete use a mortar leveling coat followed by a Dry-Set Latex modified Portland Cement Bond Coat conforming to TCA Detail W-211.

J. Floor Tile - Mud Set: Set floor tile using latex modified Portland Cement bond coat conforming to TCA Detail F-121.

K. 100% Solids Epoxy Grout (meeting 118.3):

1. MAEI Keropoxy IEG.

2. Laticrete 2000.

3. Customs 100% Solid Epoxy.

4. ProSpec B7000.

5. Color selected by the Architect.

L. Physical Properties: The setting beds and grouts must meet the following physical requirements:

1. Compressive Strength - 3000 psi min.

2. Shear Bond Strength - 500 psi min.

3. Water Absorption - 4.0% max.

4. Service Rating (ASTM C 627) - Extra Heavy Duty.

2.3 SEALANT AND ACCESSORIES

A. Joint Backing: Preformed, compressible, resilient, non-extruding, non-staining strips of foam neoprene, foam polyethylene or other material recommended by sealant manufacturer.

B. Sealant: Two-part polyurethane sealant, self-leveling, conforming to Fed. Spec. TT-S-00227E, Class A, Type 1, equal to "THE/900" made by Tremco or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions where quarry tile is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 CONDITION OF SURFACES

A. Allowable Variations in Substrate Levels for Floors: +/-1/8" in 10'-0" distance and 1/4" total maximum variation from levels shown.

B. Grind or fill concrete substrates as required to comply with allowable variations.

3.3 PREPARATION

A. Etch concrete substrate as may be required to remove curing compounds or other substances that would interfere with proper bond of setting bed. Rinse with water to remove all traces of treatment. Surface must meet finish requirements per ANSI 108.01.

B. Seal substrate with sealer as recommended by manufacturer of mortar or adhesive.

3.4 JOINTS IN TILE WORK

A. Joint Widths: 1/4" wide.

B. Alignment: Base and floor joints shall align through the field and trim. Direction and location of all joints shall be as directed by the Architect.

C. Provide expansion joints where tile abuts restraining surfaces and directly over joints in structural floor. Install expansion joints in accordance with TCA "Handbook for Ceramic Tile Installation."

3.5 INSTALLATION

A. Allowable Variations in Finished Work: Do not exceed the following deviations from level and plumb, and from elevations, locations, slopes and alignment shown.

1. Floors: 1/8" in 10'-0" run, any direction; +\-1/8" at any location; 1/32" offset at any location.

2. Joints: +1/32" joint width variation of any location; 1/16" in 3'-0" run deviation from plumb and true.

B. Waterproofing Membrane

1. Install the membrane in strict accordance with manufacturer's written recommendations.

2. Upon completion of work, test horizontal membrane for leaks by plugging the drain or damming areas and filling with water for a period of 48 hours minimum. Inspect for leakage. Make necessary adjustments to stop all leakage and retest until watertight. If membrane is not covered by another surface immediately, provide protection until membrane is covered.

C. Comply with the ANSI standard installation specifications A108.1 and A108.10 and TCA Detail F-121. Provide minimum temperature limits and installation practices as recommended by mortar and grout materials manufacturers.

1. Setting bed shall provide for an average contact area of not less than 95%.

D. Extend tile work into recesses and under equipment and fixtures to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disruption of pattern or joint alignments.

E. Comply with manufacturer's instructions for the mixing and installation of materials.

F. Neutralize and seal substrates in accordance with the mortar manufacturer's instructions.

G. Lay tile on grid pattern. Align joints when adjoining tiles on floor, base and trim are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Provide uniform joint widths. Adjust to minimize tile cutting.

3.6 CLEANING AND PROTECTION OF QUARRY TILE

A. Upon completion of placement and grouting, clean all quarry tile surfaces so they are free of foreign matter. Tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but not sooner than 14 days after installation. Flush surface with clean water before and after cleaning.

B. Apply to all clean completed tile a protective coating of neutral cleaner solution, 1 part cleaner to 1 part water.

C. Leave finished installation clean and free of cracked, chipped, broken, unbonded or otherwise defective tile work.

D. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent damage and wear. Prohibit foot and wheel traffic from tiled floors for at least 3 days after grouting is completed. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION

SECTION 095113

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the acoustical panel ceilings as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Acoustical panel units.
2. Exposed "T" suspension system, including hangers and inserts.
3. Provisions for the installation of lighting fixtures, diffusers, grilles and similar items provided under other Sections.
4. Cutting, drilling, scribing and fitting as required for electro-mechanical penetrations.
5. Perimeter and column moldings, trim and accessories for acoustical ceilings.

1.3 RELATED SECTIONS

A. Steel Deck - Section 053100.

B. Drywall ceilings - Section 092900.

C. Diffusers, grilles and related frames - Division 23.

D. Lighting fixtures - Division 26.

1.4 QUALITY ASSURANCE

A. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations published by the Ceilings and Interior Systems Contractor's Association.

B. Qualifications of Installers

1. The suspended ceiling subcontractor shall have a record of successful installation of similar ceilings acceptable to Architect and shall be currently approved by the manufacturer of the ceiling suspension system.
2. For the actual fabrication and installation of all components of the system, use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.

C. The work is subject to the following standards:

1. ASTM C 635 "Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings," American Society for Testing and Materials.

2. ASTM C 636 "Standard Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels," American Society for Testing and Materials.

D. In addition to suspension system specified, provide seismic struts and seismic clips to meet seismic standards as required by prevailing Codes and Ordinances.

1.5 SUBMITTALS

A. Shop Drawings: Submit completely dimensioned ceiling layouts for all areas where acoustical ceilings are required, showing:

1. Any deviations from Architect's reflected ceiling plan layouts, especially lighting fixture and dimensions. Also indicate if any light fixtures will not fit into Architect's ceiling layout due to dimensional restrictions or field conditions.

2. Direction and spacing of suspension members and location of hangers for carrying suspension members.

3. Direction, sizes and types of acoustical units, showing suspension grid members, and starting point for each individual ceiling area.

4. Moldings at perimeter of ceiling, at columns and elsewhere as required due to penetrations or exposure at edge of ceiling tiles.

5. Location and direction of lights, air diffusers, air slots, and similar items in the ceiling plane.

6. Details of construction and installation at all conditions.

7. Materials, gauges, thickness and finishes.

B. Samples and Product Literature: Submit the following samples and related manufacturer's descriptive literature.

1. Twelve (12) inch long components of suspension systems, including moldings.

2. Acoustical units — full size.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Do not install acoustical ceilings until wet-work in space is completed and nominally dry, work above ceilings has been completed, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.8 COORDINATION

A. Coordinate layout and installation of acoustical ceiling units and suspension system components with other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment, fire suppression system components, and partition system.

1.9 EXTRA STOCK

A. Extra Stock: Deliver stock of maintenance material to Owner. Furnish maintenance material matching products installed, packaged with protective covering for storage and identified with appropriate labels.

1. Acoustical Ceiling Units: Furnish quantity of full size units equal to 2.0% of amount installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

A. ACC-1: Provide 24" x 60" x 3/4" thick fiberglass panels with inherent mold resistance equal to "Ecophon Focus Dg" with concealed frame, as manufactured by CertainTeed Ceilings, or equal made by Armstrong World Industries or USG Interiors, Inc. Panels shall have light reflectance value of 0.85, and shall meet ASTM E 1264, Type XII, Form 2, Pattern G, Class A, with minimum flame spread of 25 and smoke developed of 50 per ASTM E 84.

B. ACT-1: Provide 3/4" thick, 24" x 48" mineral fiber panels equal to "Ultima High NRC," No. 1944, with beveled tegular edge, as manufactured by Armstrong World Industries, or equal made by USG Interiors, Inc. or Rockwool Rockfon. Panels shall have factory applied white finish with light reflectance value of 0.87. Panels shall meet ASTM E 1264, Type IV, Form 2, Pattern E, Class A, with minimum flame spread of 25 and smoke developed of 50 per ASTM E 84.

1. Suspension System: "Silhouette XL 1/8" Reveal Bolt Slot System" 9/16" slotted tee system made by Armstrong World Industries, or equal made by USG Interiors, Inc. or Chicago Metallic Corp.

C. ACT-2: Provide 24" x 60" x 3/4" thick fiberglass panels with inherent mold resistance equal to "Ecophon Focus Dg" with semi-concealed edge, color White, as manufactured by CertainTeed Ceilings, or equal made by Armstrong World Industries or USG Interiors, Inc. Panels shall have light reflectance value of 0.85, and shall meet ASTM E 1264, Type XII, Form 2, Pattern G, Class A, with minimum flame spread of 25 and smoke developed of 50 per ASTM E 84.

1. Provide 15/16" exposed-tee steel suspension system with low sheen white baked enamel finish.

D. ACT-3: Provide 24" x 60" x 3/4" thick fiberglass panels with inherent mold resistance equal to "Ecophon Focus Dg" with semi-concealed edge, custom color as scheduled on the Materials List, as manufactured by CertainTeed Ceilings, or equal made by Armstrong World Industries or USG Interiors, Inc. Panels shall have light reflectance value of 0.85, and shall meet ASTM E 1264, Type XII, Form 2, Pattern G, Class A, with minimum flame spread of 25 and smoke developed of 50 per ASTM E 84.

1. Provide 15/16" exposed-tee steel suspension system with low sheen white baked enamel finish.

2.2 SUSPENSION SYSTEM

A. The suspension system shall support the ceiling assembly shown on the drawings and specified herein, with a maximum deflection of 1/360 of the span, in accordance with ASTM C 635.

B. Provide min. 12 ga. galvanized wire hangers, soft annealed steel conforming to ASTM A 641, prestretched, Class 1 zinc coating, soft temper, size so that stress at 3 times hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than yield stress of wire.

C. Provide ceiling clips and inserts to receive hangers, type as recommended by suspension system manufacturer, sizes for pull-out resistance of not less than five (5) times the hanger design load, as indicated in ASTM C 635.

D. Suspension systems shall conform to ASTM C 635, intermediate duty.

E. Provide manufacturer's standard wall moldings with off-white baked enamel finish to match suspension systems. For circular penetrations of ceilings, provide edge moldings fabricated to diameter required to fit penetration exactly.

F. Specialized hangers per Section 092900 and Acoustic Report per Appendix.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas where acoustical panel ceilings are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected to permit proper installation of the layout.

3.2 PREPARATION

A. Coordination: Furnish layouts for inserts, clips, or other supports required to be installed by other trades for support of acoustical ceilings.

B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION

A. Codes and Standards: Install materials in accordance with manufacturer's printed instructions, and to comply with governing regulations and industry standards.

B. Install suspension systems to comply with ASTM C 636, with wire hangers supported only from building structural members. Locate hangers not more than 6" from each end and spaced 4'-0" along direct-hung runner, leveling to tolerance of 1/8" in 12'-0".

C. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.

D. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum which are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, reinforcing, countersplaying or other equally effective means.

E. Install edge moldings at edges of each acoustical ceiling area, and at locations where edge of acoustical units would otherwise be exposed after completion of the work.

1. Secure moldings to building construction by fastening through vertical leg. Space holes not more than 3" from each end and not more than sixteen (16) inches o.c. between end holes. Fasten tight against vertical surfaces.

2. Level moldings with ceiling suspension system, to a level tolerance of 1/8" in 12'-0".

F. Install acoustical units in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

G. Install hold-down clips in toilet areas, and in areas where required by governing regulations; space 2'-0" o.c. on all cross tees.

H. Light fixtures or other ceiling apparatus shall not be supported from main beams or cross tees if their weight causes the total load to exceed the deflection capability of the ceiling suspension system. In such cases the load shall be supported by supplemental hangers furnished and installed by this Section of work.

I. Where fixture or ceiling apparatus installation causes eccentric loading on runners, provide stabilizer bars to prevent rotation.

3.4 ADJUST AND CLEAN

A. Clean exposed surfaces of acoustical ceilings, including trim, edge molding, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 095426

LINEAR WOOD CEILINGS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the wood ceilings, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Concealed suspension system for Linear Wood Ceiling Panels.
2. Linear Wood Ceiling Panels for concealed suspension system.
3. Trim and accessories.
4. Seismic restraints for suspended ceiling system.

1.3 RELATED SECTIONS

A. Sprinklers - Division 21.

B. Diffusers - Division 23.

C. Lighting fixtures - Division 26.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s technical information for wood ceiling panel systems.

B. Shop Drawings: Submit completely dimensioned ceiling layouts for all areas where wood panel ceilings are required, showing:

1. Any deviations from Architect's reflected ceiling plan layouts, especially lighting fixture and dimensions. Also indicate if any light fixtures will not fit into Architect’s ceiling layout due to dimensional restrictions or field conditions.
2. Direction and spacing of suspension members and location of hangers for carrying suspension members.
3. Direction, sizes and types of wood panel units, showing suspension grid members and starting point for each individual ceiling area.
4. Moldings at ceiling perimeters and penetrations.
5. Location and direction of lights and similar items in the ceiling plane.

6. Details of construction and installation at all conditions.

7. Materials, gauges, thickness and finishes.

C. Samples: Submit samples, including manufacturer's descriptive literature for:

1. All components of suspension systems, including moldings.

2. Wood ceiling panel assembly, 24" square, stained to match Architect’s selected color.

1.5 QUALITY ASSURANCE

A. Qualifications of Installers

1. The suspended ceiling subcontractor shall have a record of successful installation of similar ceilings acceptable to the Architect, and shall be currently approved by the manufacturer of the ceiling suspension system.

2. For the actual fabrication and installation of all components of the system, use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations published by the Ceilings and Interior Systems Contractors' Association (CISCA).

C. Fire Performance Characteristics: When specified as "Fire Resistant," the wood acoustical ceiling panels shall be constructed using fire retardant core components meeting or exceeding the requirements of ASTM E 84 Class A.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood ceiling materials to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, or other causes.

B. Handle wood panel units carefully to avoid damaging units in any way.

C. Material must be stored and installed only in a secure ambient environment with humidity a minimum of 25% and maximum of 55%.

1.7 COORDINATION

A. Coordinate layout and installation of wood ceiling and suspension system components with other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment, fire suppression system components (if any), and partition system.

1.8 DELIVERY, STORAGE AND HANDLING

A. Ceiling components shall be delivered to the project site in original, unopened packages.

B. Ceiling system materials shall be stored flat and level in a fully enclosed space. For a minimum of seventy-two (72) hours immediately prior to ceiling installation, the linear wood strips shall be stored in the room in which they will be installed. The temperature

and humidity of the room shall closely approximate those conditions that will exist when the building is occupied. The linear wood strips shall be stored off the floor.

C. Care in handling must be exercised to avoid damage.

1.9 WARRANTIES

A. Manufacturer: All materials supplied by the manufacturer of the ceiling system shall be guaranteed against manufacturing defects for one (1) year. Because of differing site conditions, wood stains and colorings can vary with age, and are excluded from this warranty.

B. Contractor: All work shall be guaranteed for one (1) year from final acceptance of completed work.

PART 2 PRODUCTS

2.1 PANELIZED WOOD CEILINGS

A. General: The following manufacturer is basis of design:

1. 9Wood, Inc. (www.9wood.com): 2400 T&G Linear.

B. Or equal, as prior approved by architect.

2.2 LINEAR WOOD CEILING PANELS

A. Basis of Design: 9Wood, Inc. Linear, Series 2000

1. Wood Panels: 2400 T&G Linear
2. Species: Hemlock, W. Maple Veneer
3. Member Size: See drawings
4. Edge Profile: V Groove
5. Reveal: Closed
6. Members/LF: See drawings
7. Assembly Style: T-Bar Z Clip
8. Fire Rating: Class 1(A) Fire Rating
9. Finish: “Dressed-to-the-Nines”™ Clear Interior Finish

2.3 2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. A. Metal T-Grid Suspension System: Provide standard interior Metal Heavy Duty 15/16” <9/16”, 1 ½”> suspension T-Grid system using Main Runners, Cross-tees, Wall Angle or Shadow Moldings of types, structural classifications, and <black> finishes indicated and that comply with applicable ASTM C 635 requirements. Comply with all applicable <seismic> codes and ordinances.

B. B. Attachment Devices: Size for 3 times the design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

C. C. Wire, Braces, Ties, Hanger Rods, Flat Hangers and Angle Hangers: Provide wires, rods and hangers that comply with applicable ASTM specifications.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas where wood ceiling panels are to be installed and correct any of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Ceiling Layout: The Contractor shall measure ceiling areas prior to installation to confirm application and establish the layout of the hangers and cliprails, in accordance with installation instructions.

B. Coordination: The Contractor shall furnish the layout for supports that shall be installed for suspension of ceilings, and coordinate with other trades the location of devices which will penetrate the ceiling panels or interfere with the installation. Recessed or surface devices located within the ceiling panels are to be located and cut in the field.

3.3 INSTALLATION

A. General: Install 9Wood, Inc. Interior Panelized Linear, Style 2400 to comply with manufacturer's instructions and CISCA "Ceiling Systems Handbook."

B. Attachments: Suspend ceiling hangers from building's structural members per manufacturer’s instructions and in compliance with all local codes and regulations.

C. Installation of Metal T-Bar Grid: Install, align, brace, tie-off, mount, handle interferences, and space suspension T-Grid in accordance with suspension manufacturer’s instructions and in compliance with all local codes and regulations.

D. Installation of Panelized Linear Wood (Style 2400): Install Linear Wood ceiling panels in accordance with manufacturer’s installation instructions and in compliance with all local codes and regulations. Install with undamaged edges and fitted accurately to suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit, as required.

E. Suspension Runners: Install suspension system runners so they are square and securely interlocked with one another. Install number and use on-center spacing per wood ceiling manufacturer’s instructions, as indicated on approved Shop Drawings and in compliance with all local codes.

3.4 ADJUSTMENT, CLEANING, AND REPAIR

A. The Contractor shall make final adjustments to level or contours.

B. Upon completion of installation, all acoustical ceiling panels shall be cleaned free of dirt, dust, grease, oils, and fingerprints. Wood surfaces shall be wiped with furniture polish to enhance the surface finish.

C. All work which cannot be successfully cleaned or repaired shall be removed and replaced.

3.5 INSPECTION

A. Upon completion of the ceiling installation, the Owner's Representative shall inspect all finished surfaces to ensure that work has been performed in a manner satisfactory to the Owner. Any deficiencies in the installed ceiling shall be corrected at no additional cost to the Owner or to the ceiling manufacturer.

END OF SECTION

SECTION 096429

ENGINEERED WOOD PLANK FLOORING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the engineered wood plank flooring, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Engineered wood plank flooring.
2. Solid hardwood plank flooring.
3. Accessories, including acoustical underlayment.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Carpentry - Section 062000.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Specialized wood flooring firm with not less than three (3) years' successful experience in installation of types specified, and acceptable to manufacturer of wood flooring.

B. General Standard: Comply with recommendations of National Wood Flooring Association (WFA) Installation Guidelines.

C. Engineered Wood Flooring: Comply with ANSI/HPVA LF.

D. Source Quality Control: Obtain flooring of each type from single manufacturer or source, to ensure match of quality, color, pattern and texture.

E. Field-Constructed Mock-Up: Prior to installing wood flooring and trim, construct mock-ups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for completed work.

1. Build mock-ups of wood flooring and each type of trim, in the form, dimensions, and location designated by the Architect.
2. Notify Architect one week in advance of the dates and times when mock-ups will be erected.
3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Modify or reinstall mock-ups as required to obtain Architect's acceptance. Simulate finished lighting conditions for reviewing mock-ups.

5. Obtain Architect's acceptance of mock-ups before start of final unit of work.

6. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed unit of work. When directed, demolish and remove mock-ups from project site, except that accepted in place mock-ups in undisturbed condition at the time of Substantial Completion may become part of completed unit of work.

F. The Contractor shall furnish a letter from the adhesive manufacturer stating that the concrete substrate has been tested for moisture vapor transmission and that the moisture vapor transmission levels do not exceed the manufacturer's recommendations.

G. All surfaces shall have a minimum wet DCOF AcuTest value of 0.42.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's detailed technical product data and installation instructions for each type of wood flooring. Include instructions for handling, storage, installation, finishing, protection and maintenance.

B. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.

C. Samples: Submit three sets of range samples for wood flooring, 36" x 36"; include finish.

1.6 DELIVERY, STORAGE AND HANDLING

A. Moisture Content: At time of delivery, limit average moisture content of wood flooring to 6%, with 8% maximum for any piece.

B. Protect wood flooring from excessive moisture in shipment, storage and handling. Deliver in unopened cartons or bundles and store in a dry place, with adequate air circulation. Do not deliver material to building until "wet work" such as concrete and plaster have been completed and cured to a condition of equilibrium.

1.7 PROJECT CONDITIONS

A. Conditioning: Do not proceed with installation of wood flooring until spaces have been enclosed. Building must be dry with all wet work (i.e. concrete, plaster, drywall, fireproofing) completed, and the space shall have been at the expected ambient temperature and relative humidity for five days. Condition wood for five (5) days prior to start of installation by placing in spaces to receive flooring and maintaining ambient conditions in which it will be used before, during and after installation. Open packages of wood flooring which are sealed to permit natural adjustment of moisture content.

1. Maintain ambient temperature between 65 and 75 deg F and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.

2. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

1.8 SPECIAL PROJECT WARRANTY

A. Engineered Wood Flooring Warranty: Written warranty, signed by manufacturer agreeing to repair or replace engineered wood flooring that fails in materials or workmanship. Failures include, but are not limited to, buckling, cupping, warping, and delamination.

1. Provide 3-year warranty on finish.

2. Provide 15-year warranty on structural wear.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

A. Engineered Wood Plank Flooring (WD-03): Havwoods USA.

1. Species: European Oak.

2. Color: As scheduled on the drawings.

3. Total Thickness: 3/4".

4. Width: 8-5/8" planks.

5. Length: Random lengths running from 4' to 8'.

6. Finish: Natural oiled.

7. Edges: Micro-beveled four sides.

B. Flooring planks shall be tongued-and-grooved and end-matched; back face of each plank shall be back channeled. Planks shall be standard random lengths, complying with grading rules. Wood shall be kiln-dried and moisture content of wood at time of installation shall not exceed 9%.

C. Wood Trim: Provide wood stripping, nosings, saddles and thresholds, as indicated in or adjacent to wood flooring, of same species, grade and cut as wood flooring.

D. Pre-finished wood flooring shall be FloorScore certified.

E. Maximum VOC content of clear wood finish applied on site is 350 g/L.

2.2 ACCESSORIES

A. Adhesive: Premium urethane/acrylic wood adhesive per flooring manufacturer's instructions.

1. Wood adhesives shall have a maximum VOC content of 30 g/L.

B. Cork Expansion Strip: Composition cork expansion strip FS HH–C–576, Type I–B, Class 2.

C. Acoustical Sealant: As recommended by flooring manufacturer.

D. Perimeter Isolation: 3/8" thick fiberglass board, 6 - 15 pcf.

E. Sound Control Mat

1. Sound Control Mat at Engineered Wood Floor: 1/8" thick Kahrs "Eco +" sound mat, or approved equal.

2. Sound Control Mat at Solid Wood Floor: "Geniemat RST-05" as manufactured by Pliteq, "QT SCU Sound Control Mat" made by Ecore International or approved equal; 1/4" thick. Bond with adhesive and vapor retarder specified herein.

F. Self-Leveling Underlayment: "DSP-520" by H. B. Fuller or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where engineered wood plank flooring is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Concrete Slabs: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than two tests in each installation area and with test areas evenly spaced in installation areas.

a. Perform anhydrous calcium chloride test per ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb. of water/1000 sq. ft. in 24 hours.

2. Relative Humidity Testing: Perform relative humidity testing using in situ probes according to ASTM F2170. Proceed with installation only after substrate have a maximum 75% relative humidity level.

B. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

C. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. General: Comply with flooring manufacturer's instructions and recommendations, but not less than recommended by NOFMA in "Hardwood Flooring Installation Material."

B. Pattern: Comply with pattern or direction of pattern for laying wood flooring, as directed by Commissioner.

C. Expansion Space: Provide expansion space at walls and other obstructions and terminations of flooring, not less than 1/2". Fill expansion space with flush cork expansion strip. Nail shoe molding or other trim to baseboard, rather than to flooring.

D. Install acoustical underlayment in accordance with manufacturer's recommendations.

E. Direct-Glue Down System: Spread glue approximately the width of two units using a square-notched trowel. Spread adhesive 2-1/2 feet to 3 feet across length of room. Do not spread more adhesive than can be covered in 30 to 45 minutes.

F. Do not use rubber mallet or hammer directly to engage tongue and groove wood flooring.

G. Allow adhesive to cure for approximately 24 hours before foot traffic.

H. Remove tape 24 to 36 hours after installation is completed.

I. Remove excess adhesive with lightly dampened clean cloth or sponge. Use mineral spirits on clean cloth on dried adhesive.

3.4 PROTECTION

A. Protect completed wood flooring during remainder of construction period with heavy Kraft paper or other suitable covering, so that flooring and finish will be without damage or deterioration at time of acceptance.

END OF SECTION

SECTION 096513

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the resilient accessories, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Rubber base.

2. Rubber stair treads and risers.

3. Accessories.

1.3 RELATED SECTIONS

A. Steel Pan Stairs - Section 055113.

B. Gypsum Drywall - Section 092900.

C. Resilient Tile Flooring - Section 096519.

D. Carpet Tile - Section 096813.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: Use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.

1.5 SUBMITTALS

A. Manufacturer's Data: For information only, submit manufacturer's technical information and installation instructions for type of resilient base.

B. Samples

1. Submit six (6) inch long samples of base.

2. Submit full-size sample of stair tread.

1.6 DELIVERY AND STORAGE

A. Deliver materials to the project site in the manufacturer's original unopened containers, clearly marked to indicate pattern, gauge, lot number and sequence of materials.

B. Carefully handle all materials and store in original containers at not less than seventy (70) degrees F. for at least forty-eight (48) hours before start of installation.

1.7 JOB CONDITIONS

A. Continuously heat spaces to receive base to a temperature of seventy (70) degrees F. for at least forty-eight (48) hours prior to installation, whenever project conditions are such that heating is required. Maintain seventy (70) degrees F. temperature continuously during and after installation as recommended by the manufacturer, but for not less than forty-eight (48) hours. Maintain a temperature of not less than fifty-five (55) degrees F. in areas where work is completed.

PART 2 PRODUCTS

2.1 RUBBER BASE

A. Provide 4" high by 1/8" thick continuous vulcanized SBR rubber top set cove base with pre-formed internal and external corner pieces, color as selected by the Architect. For areas to receive carpet, provide flat base, no cove. Base shall conform to ASTM F 1861, Type TS, Group 1 (solid) as manufactured by Nora Systems, Inc., or equal by Armstrong, Johnsontie, Roppe, or approved equal.

B. Rubber base shall meet requirements of ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials, Class A, Smoke Developed <450.

2.2 RUBBER STAIR TREADS AND RISERS

A. Provide "Norament 920" one-piece rubber stair tread and integrated riser as manufactured by Nora Systems, Inc., or equal by Armstrong, Johnsontie, Roppe, or approved equal. Treads shall be in lengths and depth to fit tread of stair. Nosings shall be square, adjustable to fit angle of stair nosing, 2" height. Color shall be as selected by the Architect. Treads shall conform to ASTM F 2169, Type TS, Class 2. Integral risers shall be smooth, flat, coved-toe, height of stair riser by length matching treads, and tapered.

2.3 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the manufacturer for the type of service indicated.

B. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

C. Concrete Slab Primer: Non-staining type recommended by the tile manufacturer.

D. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. DSP-520 made by H.B. Fuller or No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where resilient base is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Bases: In all spaces where base is indicated, install bases tight to walls, partitions, columns, built-in cabinets, etc., without gaps at top or bulges at bottom, with tight joints and flush edges, with molded corner pieces at internal and external corners. Provide end stops adjacent to flush type door frames and where

base does not terminate against an adjacent surface. Keep base in full contact with walls until adhesive sets.

B. Stair Treads

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.

2. Tightly adhere to substrates throughout length of each piece.

3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

3.3 CLEANING AND PROTECTION

A. Remove any excess adhesive or other surface blemishes from base using neutral type cleaners as recommended by the manufacturer.

END OF SECTION

SECTION 096519

RESILIENT TILE FLOORING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the resilient tile flooring, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Bio-based tile.
2. Static-dissipative tile.
3. Rubber tile flooring.
4. Transition strips.
5. Accessories.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Resilient Base and Accessories - Section 096513.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: Use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.

1.5 SUBMITTALS

A. Manufacturer's Data: For information only, submit manufacturer's technical information and installation instructions for type of resilient tile.

B. Samples

1. Submit full-size sample tiles for each type and color required, representative of the expected range of color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
2. Submit six (6) inch long samples of transition strips

1.6 DELIVERY AND STORAGE

A. Deliver materials to the project site in the manufacturer's original unopened containers, clearly marked to indicate pattern, gauge, lot number and sequence of materials.

B. Carefully handle all materials and store in original containers at not less than seventy (70) degrees F. for at least forty-eight (48) hours before start of installation.

1.7 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.

2. During installation.

3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.1 BIO-BASED TILE

A. See drawings.

2.2 STATIC-DISSIPATIVE TILE

A. See Drawings.

2.3 RUBBER TILE

A. See Drawings

2.4 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the tile manufacturer for the type of service indicated.

B. Concrete Slab Primer: Non-staining type recommended by the tile manufacturer.

C. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. DSP-520 made by H.B. Fuller or No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, or approved equal.

D. Edging Strips: 1/8" thick, homogeneous vinyl or rubber composition, tapered or bullnose edge, color as selected by the Architect from manufacturer's standards.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where resilient tile flooring is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 CONDITION OF SURFACES

A. Allowable Variations in Substrate Levels (Floors): ± 1/8" in 10'-0" distance and 1/4" total maximum variation from levels shown.

B. Grind or fill concrete substrates as required to comply with allowable variation.

3.3 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:

a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb. of water/1000 sq. ft. in 24 hours.
b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.4 INSTALLATION

A. Install tile only after all finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of concrete slabs, building air temperature and relative humidity must be within limits recommended by tile manufacturer.

B. Place tile units with adhesive cement in strict compliance with the manufacturer's recommendations. Butt tile units tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions and to produce neat joints, laid tight, even and in straight, parallel lines. Extend tile units into toe spaces, door reveals, and into closet and similar openings.

C. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on the finish tile as marked in the subfloor. Use chalk or other non-permanent marking devices.

D. Lay tile from center marks established with principal walls, discounting minor off-sets, so that tile at opposite edges of the room are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.

E. Match tiles for color and pattern by using tile from cartons in the same sequence as manufactured and packaged. Cut tile neatly to and around all fixtures. Broken, cracked, chipped or deformed tile is not acceptable.

F. Tightly cement tile to sub-base without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks through tile, or other surface imperfections.

G. Lay tile with grain in all tile running in the same direction.

H. Place resilient edge strips tightly butted to tile and secure with adhesive. Provide edging strips at all unprotected edges of tile, unless otherwise shown.

3.5 CLEANING AND PROTECTION

A. Remove any excess adhesive or other surface blemishes from tile, using neutral type cleaners as recommended by the tile manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.

END OF SECTION

SECTION 096566

RESILIENT ATHLETIC FLOORING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the resilient athletic flooring, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Rubber interlocking tile flooring.

2. Rubber sheet flooring.

3. Adhesive.

4. Accessories.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer or applicator who has specialized in installing rubber flooring similar to that required for this Project and who is acceptable to manufacturer of primary materials and has a minimum of 5 years' experience installing this floor system.

B. Single-Source Responsibility: Obtain rubber flooring materials, including primers, resins, hardening agents, and finish or sealing coats, from a single manufacturer.

1.5 SUBMITTALS

A. Manufacturer's Data: For information only, submit manufacturer's technical information and installation instructions for type of rubber flooring required.

B. Samples: Submit samples of each color of rubber flooring required. Provide twelve (12) inch square samples to illustrate the range of color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1. For sheet flooring, submit 12 long sample of heat welded seam.

C. Maintenance Instructions: Submit two (2) copies of manufacturer's written instructions for recommended maintenance practices for rubber flooring.

D. Certificates: Submit material certificates signed by manufacturer certifying that the rubber flooring complies with requirements specified herein.

E. Shop Drawings: Submit shop drawings of pattern and color layout for floor surface, including location of seams. Show all dimensions.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels containing brand name and directions for storage and mixing with other components.

B. Store materials to comply with manufacturer's directions to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Comply with flooring manufacturer's directions for maintenance of ambient and substrate temperature, moisture, humidity, ventilation, and other conditions required to execute and protect Work.

B. Lighting: Permanent lighting will be in place and working before installing rubber flooring.

C. Coordination: Coordinate installation of rubber flooring with installer of radiant heat flooring system.

1.8 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 RUBBER TILE FLOORING

A. Provide 2-3/4" thick Geniemat FIT 70 interlocking tile or approved equal; color as selected by the Architect.

1. Tile Size: 23-7/8" x 23-7/8".

2. Thickness: 2-3/4".

2.2 RESILIENT SHEET FLOORING

A. Provide 3/8" thick, heavy-duty, commercial rolled rubber recycled flooring by Rubber Flooring Inc.; or 5/16" (nominal 8mm) thick resilient floor covering made from recycled rubber and colored EPDM granules; "GenieMat FIT08" as manufactured by Pliteq Inc., or approved equal; color as selected by the Architect.

2.3 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the manufacturer for the type of service indicated.

B. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, H.B. Fuller, or approved equal.

C. Concrete Slab Primer: Non-staining type as recommended by the rubber flooring manufacturer.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where the resilient athletic flooring is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Architect.

1. Concrete substrate shall be in place a minimum of thirty days prior to the installation of the rubber flooring.

2. Moisture content of the substrate shall not exceed 3%.

3. Inserts, penetrations and other construction items which affect the installation of the prefabricated rubber flooring shall be in place.

3.2 PREPARATION

A. Substrate: Perform preparation and cleaning procedures according to flooring manufacturer's instructions for particular substrate conditions involved, and as specified. Provide clean, dry, and neutral substrate for flooring application.

1. Correct deficiencies in substrate prior installation.

2. Lightly grind concrete subfloors with a terrazzo grinder to remove any trowel marks or other surface irregularities which will telegraph to the tile flooring surface. If grinding is not required, acid etch floor with ten (10) percent muriatic acid as required to remove any curing compound that would interfere with adhesive bond.

3. Use leveling compound as recommended by tile flooring manufacturer for filling small cracks and depressions in subfloors.

4. Subfloor shall be level to ±1/8" in 10'-0" distance and 1/4" total maximum variation from level shown.

5. Perform moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured and are ready to receive flooring installation.

B. Concrete Primer: Apply concrete slab primer if recommended by the tile flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's directions.

3.3 TILE FLOORING INSTALLATION

A. Install rubber flooring in accordance with manufacturer’s recommendations.

B. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered.

C. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.

D. Cut tile neatly around all fixtures. Broken, cracked, chipped, or deformed tiles are not acceptable. Generally, lay tile with grain running in one direction unless shown or otherwise directed. Verify grain direction with Architect prior to installation.

3.4 SHEET FLOORING INSTALLATION

A. Install sheet flooring only after all finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of concrete slabs, building air temperature and relative humidity must be within limits recommended by sheet flooring manufacturer.

B. Place sheet flooring with adhesive cement in strict compliance with the manufacturer's recommendations. Butt tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions and to produce neat joints, laid tight, even and in straight, parallel lines. Extend sheet flooring into toe spaces, door reveals, and into closet and similar openings.

C. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on the finish flooring as marked in the subfloor. Use chalk or other non-permanent marking devices.

D. Lay sheet flooring to substrate without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.

E. Lay sheet flooring to provide as few seams as possible. Match edges for color shading and pattern at seams in compliance with the manufacturer's recommendations, such as reversing adjoining sheets of the same roll, so that abutting edges are from the same edge of the roll.

F. Weld seams in sheet flooring in compliance with the manufacturer's instructions to provide a "seamless" installation.

G. Place resilient edge strips tightly butted to sheet flooring and secure with adhesive. Provide edging strips at all unprotected edges of sheet flooring, unless otherwise shown.

3.5 CLEANING AND PROTECTION

A. Remove any excess adhesive or other surface blemishes from tile flooring, using neutral type cleaners as recommended by the tile flooring manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.

B. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

1. Cover flooring with undyed, untreated building paper until Substantial Completion.

2. Do not move heavy and sharp objects directly over rubber flooring. Place plywood or hardboard panels over flooring and under objects while they are being moved.

END OF SECTION

SECTION 096813

CARPET TILE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor materials, equipment and services necessary to complete the carpet tile as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Carpet tile.

2. Adhesive.

1.3 RELATED SECTIONS

A. Concrete sub-floor – Section 033000.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm with not less than five (5) years of experience in installation of commercial carpeting of type, quantity and installation methods similar to work of this Section.

B. General Terminology/ Information Standard: Refer to current edition of "Carpet Specifier's Handbook" by The Carpet and Rug Institute; for definitions of terminology not otherwise defined herein, and for general recommendations and information.

C. Carpet used on Project must be from same dye lot for each carpet type.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's complete technical product data for each type of carpet, cushion and accessory item required.

B. Samples: Submit full size samples of carpet tile and six (6) inches long samples of each type exposed edge stripping.

C. Certification: Submit manufacturer's certification stating that carpet materials furnished comply with specified requirements.

1. Include listing of mill register numbers for carpet furnished.

2. Include supporting certified laboratory test data indicating that carpet meets or exceeds specified test requirements.

D. Maintenance Data: Submit manufacturer's printed maintenance recommendations, including methods and frequency recommended for maintaining carpet in optimum conditions under anticipated traffic and use conditions.

1.6 EXTRA STOCK

A. Produce and deliver to project at least five (5) percent overrun on calculated yardage. Provide required overrun exclusive of carpet needed for proper installation, waste and usable scraps.

1.7 PRODUCT DELIVERY AND STORAGE

A. Deliver carpeting materials in original mill protective wrapping with mill register numbers and tags attached. Store inside, in well ventilated area, protected from weather, moisture and soiling.

1.8 WARRANTY

A. Provide special project warranty, signed by Contractor and Manufacturer (Carpet Mill), agreeing to repair or replace defective materials and workmanship of carpeting work during two (2) year warranty period following substantial completion. Attach copies of product warranty.

PART 2 PRODUCTS

2.1 CARPET TILE

A. Provide carpet tile of design and color scheduled on the drawings.

2.2 ACCESSORIES

A. Adhesive for Carpet Tile: Provide release type adhesive as recommended by the carpet tile manufacturer for use with carpet tile specified. Provide adhesive which complies with flame spread rating required for the carpet installation.

B. Miscellaneous Materials: Provide the types of adhesives and tape, and other accessory items recommended by the carpet manufacturer and Installer for the conditions of installation and use.

C. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. DSP-520 made by H.B. Fuller or No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where carpet tile is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PRE-INSTALLATION REQUIREMENTS

A. Floor shall be clean and free of cracks and protrusions. Any gaps or cracks more than 1/16" wide to be filled in with latex leveling compound. Protrusions must be sanded down smooth, the floor cleanly swept and vacuumed if necessary to remove all dust and grit.

B. Floor temperature shall be 65 deg., at least 24 hours prior to installation; and 48 hours after carpet is installed.

C. Conduct a moisture test. The presence of moisture in the concrete floor will interfere with the curing and subsequent performance of the adhesive. Conduct RH Probe Test per ASTM F2170.

D. Sequence carpeting with other work so as to minimize possibility of damage and soiling of carpet during remainder of construction period.

3.3 INSTALLATION, GENERAL

A. Comply with manufacturer's instructions and recommendations. Maintain direction of pattern and texture, including lay of pile.

B. Adhere all tiles with a full spread of adhesive. Dry-fit cut tiles and apply adhesive to tile back after tile has been cut.

C. Tiles shall be installed in a monolithic corner to corner manner following arrows printed on back of each tile indicating pile direction. Tiles shall be installed to achieve patterns as directed by the Architect.

D. Vinyl reducer strips shall be used along any necessary open edges so as to maintain the fixed perimeter.

3.4 CLEANING UP

A. Upon completion of the carpeting installation in each area, visually inspect all carpet installed in that area and immediately remove all dirt, soil, and foreign substance from the exposed face; inspect all adjacent surfaces and remove all marks and stains caused by the carpet installation: remove all packaging materials, carpet scraps, and other debris from the carpet installation to the area of the job site set aside for its storage.

3.5 PROTECTION

A. In all areas, provide a temporary non-staining paper pathway in the direction of traffic.

END OF SECTION

SECTION 096816

SHEET CARPETING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the carpeting as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Broadloom carpet, glue down installation, including carpet pad.

a. Front-of-House Carpet: PA provided, GC installed.
b. Back-of-House Carpet: GC provided and installed.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm with not less than five (5) years of experience in installation of commercial carpeting of type, quantity and installation methods similar to work of this Section.

B. Manufacturer Qualifications: Firm (carpet mill) with not less than five (5) years of production experience with carpet similar to types specified in this Section; and whose published product literature clearly indicates general compliance of products with requirements of this Section.

C. General Terminology/ Information Standard: Refer to current edition of "Carpet Specifier's Handbook" by The Carpet and Rug Institute; for definitions of terminology not otherwise defined herein, and for general recommendations and information.

D. Carpet used on Project must be from same dye lot for each carpet type.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's complete technical product data for each type of carpet and accessory item required.

B. Shop Drawings: Submit carpet layout and seaming drawings, clearly indicating carpet directions, locations and methods of jointing seams and locations and types of edge strips. Indicate columns, doorways, enclosing wall/partitions, built-in cabinets and locations where cut-outs are required in carpet.

C. Samples: Submit 18" x 27" samples of each carpet required and six (6) inch long samples of each type exposed edge stripping.

D. Certification: Submit manufacturer's certification stating that carpet materials furnished comply with specified requirements.

1. Include listing of mill register numbers for carpet furnished.

2. Include supporting certified laboratory test data indicating that carpet meets or exceeds specified test requirements.

E. Maintenance Data: Submit manufacturer's printed maintenance recommendations, including methods and frequency recommended for maintaining carpet in optimum conditions under anticipated traffic and use conditions.

1.6 EXTRA STOCK

A. Attic Stock: Produce and deliver to project at least 1000 sq. ft. for attic stock. Provide required attic stock exclusive of carpet needed for proper installation, waste and usable scraps.

1.7 PRODUCT DELIVERY AND STORAGE

A. Deliver carpeting materials in original mill protective wrapping with mill register numbers and tags attached. Store inside, in well ventilated area, protected from weather, moisture and soiling.

1.8 WARRANTY

A. The Contractor shall promptly repair seams and edges in the carpet as required, for a period of two (2) years after Substantial Completion of the Project. The exact time for this work shall be left to the discretion of the Owner. Fourteen (14) day notice for repairs shall be given by the Owner, so that the Contractor can make the necessary arrangements.

B. The manufacturer shall provide a warranty that the face yarn of the carpet will not wear more than ten (10) percent in five years. If the carpet wears more than ten (10) percent in five (5) years, the manufacturer will replace the carpet including parts, labor and materials, to the Owner’s satisfaction.

PART 2 PRODUCTS

2.1 CARPETING

A. Manufacturer: Refer to Materials List on the drawings for patterns and colors.

2.2 ACCESSORIES

A. Provide aluminum edges, reducers and threshold plates where required, sized to be compatible with the thickness of the carpet. The type shall be as required by site conditions, as is the custom of the trade, and installation shall be made as recommended by the manufacturer.

B. Metal Transition Strips: To transition to lower floor coverings, where indicated, provide transition strips as manufactured by Schlüter Systems, or approved equal; extruded aluminum, color AT Satin Nickel, of width shown, of height required to protect exposed edges, and in maximum available lengths to minimize running joints.

C. Adhesive: Provide adhesive as recommended by the carpet manufacturer. Provide adhesive which complies with flame spread rating required for the carpet installation, if any.

D. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. DSP-520 made by H.B. Fuller or No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, or approved equal.

E. Miscellaneous Materials: Provide the types of seaming, adhesives and tape, thread, and other accessory items recommended by the carpet manufacturer and Installer for the conditions of installation and use.

F. If concrete underlayment has not achieved correct moisture content for carpet adhesive, apply a sealer before installation of carpet.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where sheet carpeting is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PRE-INSTALLATION REQUIREMENTS

A. Floor shall be clean and free of cracks and protrusions. Any gaps or cracks more than 1/16" wide to be filled in with latex leveling compound. Protrusions must be sanded down smooth, the floor cleanly swept and vacuumed if necessary to remove all dust and grit.

B. Floor temperature shall be 65 deg., at least 24 hours prior to installation; and 48 hours after carpet is installed.

C. Conduct a moisture test. The presence of moisture in the concrete floor will interfere with the curing and subsequent performance of the adhesive. Conduct RH Probe Test per ASTM F2170.

D. Sequence carpeting with other work so as to minimize possibility of damage and soiling of carpet during remainder of construction period.

3.3 INSTALLATION

A. General

1. Comply with manufacturer's instructions and recommendations. Place seams in the directions as accepted on shop drawings. Maintain direction of pattern and texture, including lay of carpeting.

2. Extend carpet under open-bottomed and raised-bottom obstructions, and under removable flanges of obstructions. Extend carpet into closets and alcoves of rooms indicated to be carpeted, unless another floor finish is indicated for such spaces. Extend carpet under all movable furniture and equipment, unless otherwise indicated.

3. Provide cut-outs for removable access devices in the substrate. Bind edges as neatly as possible and secure both sides of cuts to the substrate. Use double-faced tape on carpet cut-outs which must be lifted from the substrate to gain access to the devices. Cut only three (3) sides wherever it is feasible to provide a carpet flat in lieu of a fully-removable cut-out.

4. Install vinyl carpet edge guard at every location where edge of carpet is exposed to traffic, except where another device is indicated.

B. Direct Glue-Down Carpet Installation

1. Select best location for a starting seam; strike a chalk line on the floor at this point. (Use white chalk; colored chalk should not be allowed on the job.)

2. Check the carpet for direction of pile lay.

3. Cut two lengths of carpet allowing about one inch to run up the walls for trimming.

4. Place the untrimmed edge of one length along the chalk line and stay-nail along its center line, parallel to the seam. During this procedure, work out any wrinkles allowing the carpet to lie smoothly on the floor. Stay-nail at approximately 12" - 18" intervals following the center line of the cut along its entire length. Make sure carpet does not shift from the chalk line.

5. After checking for pile direction, unroll second length and overlap the edge of the first length by about 1" to 2". Stay-nail second length as in Para. 4 above.

6. Depending on construction, the carpet edge may be trimmed by one of the following techniques:

    a. Utilizing a top cutter cut between the loops if rows are straight and the cut is not too long.
    b. Scribe cut using a top cutter or cushion back cutter to follow a row on one edge, then overlap and use this cut edge as a guide to trim the second or bottom edge.
    c. Double cut using a top cutter, make a free hand cut through both overlapped edges. When cutting long areas, utilize an electric cutter.
    d. All cut edges must be sealed prior to seaming using a premium latex carpet seaming adhesive.

7. Fold back both lengths towards stay-nails. Do not pull out any stay-nails or tear carpet.

8. The exposed floor between the folded cuts shall be swept and vacuumed if necessary.

9. Using a notched trowel 1/8" x 1/8" spread adhesive evenly, using a semi-circular motion to avoid excessive deposits and missed areas. The number of men required to spread the adhesive will depend on the areas to be covered. If the area is large, use 2 men, one on either side of the center, and have them work in opposite directions. Check the trowels occasionally to see that they are free of foreign matter and also that the 1/8" notch is maintained. It is important to allow sufficient open time in order to let the adhesive become tacky before adhering the carpet.

10. After the adhesive is spread as described in Para. 9 above, lay the folded back edge of the first cut over the cement. To do this, the installers shall position themselves at intervals along the entire length of the fold and grasp the folded edge. Lift it up and walk towards the seam. The installer in the middle of the roll walks ahead, thus forming a wedge. Use a 100 lb. roller to smooth the fabric towards the seam.

11. Next, grasp the folded edge of the second roll and place it over the adhesive as in Para. 10 with the exception that this flap should be walked in evenly rather than using the wedge method. Walk in all but one ft. of this and fold this amount back again.

12. The installer shall now slide this edge until it tightly abuts the edge of the first roll. Hold the edge in place by kneeling on it and work the wrinkles out toward the unglued side.

13. Continue the above procedure throughout the installation.

14. While the cement is still tacky, the carpet must be pressed down along the wall and creased - the excess shall be trimmed.

15. Cross-seaming can be accomplished by Scribe Cutting. Overlap the ends approximately 4". Cut the end with the yarn leaning toward the seam from the back with a straight edge. Use this end as a guide to cut the other end utilizing a top cutter or similar tool.

16. Seal these ends the same as all other cut edges.

17. Exposed edges shall always be protected by a vinyl edging. The vinyl edge shall be fastened to the floor with contract cement.

18. Stains caused by adhesive can be removed using a dry chlorinated or similar solvent. Apply solvent with a clean cloth using a blotting action. Do not saturate carpet with solvent. Dry with rag or tissue using a blotting and not a rubbing motion.

3.4 CLEANING UP

A. Upon completion of the carpeting installation in each area, visually inspect all carpet installed in that area and immediately remove all dirt, soil, and foreign substance from the exposed face; inspect all adjacent surfaces and remove all marks and stains caused by the carpet installation: remove all packaging materials, carpet scraps, and other debris from the carpet installation to the area of the job site set aside for its storage.

B. Usable carpet pieces shall be turned over to the Owner.

3.5 PROTECTION

A. Provide temporary, protection against soiling or damage of carpet for the remainder of the construction period.

END OF SECTION

SECTION 097500

INTERIOR STONE CLADDING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the interior stone cladding as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Interior stone facing panels, special shapes, piecework, and all other stone elements for interior walls.

2. Stone facing at millwork, and where indicated.

3. Furnishing, cutting, fabricating, delivery, and setting of all stonework.

4. Anchors, dowels, cramps, bolts, nuts, threaded studs, expansion shields, inserts, loose clips, loose angles, struts, relieving angles, support angles, shims, steel frame supports, wire anchors, tape, and all other fastening devices and accessories necessary for complete setting and anchorage of stone wall facings to masonry backing.

5. Protection of stone during transit, storage, erection, and installation. Cleaning of stone prior to acceptance.

6. Shop drawings, setting drawings, and samples for work of this section.

1.3 RELATED SECTIONS

A. Exterior Stone Cladding - Section 044200.

B. Stone Countertops - Section 123640.

1.4 DOCUMENTATION

A. The drawings (floor plans and design details) and specifications are an outline of the criteria and performance requirements of the work. The requirements shown by the details are intended to establish basic dimensions of the module and the site lines and profiles of members. Within these parameters, the Contractor is responsible for the design and engineering of the system, including whatever modifications or additions may be required to meet the specified requirements and maintain the visual design concept for the entire work of this Section.

B. It is recognized that the design details do not cover every condition. It is, however, intended that any conditions not detailed shall be developed through the Contractor's shop drawings to the same level of aesthetics and in compliance with performance criteria, as indicated for detailed areas and stipulated in these specifications. The Contractor, by accepting a contract for the work, acknowledges this and agrees that the Architect shall have the final say as to all matters whether detailed or not on the design details.

1.5 QUALITY ASSURANCE

A. The work of this Section shall be performed by Contractor who is regularly engaged in the installation and sealing of similar work. Contractor shall demonstrate to satisfaction of the Architect that he has successfully performed on comparable projects over the previous five years.

B. Stonework Foreman: Installation firm for stonework of this project shall have on staff a Supervising Foreman assigned full time to this Project, from time of mock-up installations, who shall have at least 10 years total stonework installation experience. Submit detailed resume of past experience with dates, duration and scope identification, project name and location, and work function of previous projects worked on.

C. Use numbers of skilled workmen equal to work requirement or occasion. The skilled workmen shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with the specific requirements and methods needed for performance of the work of this Section.

D. The Architect reserves the right to visit the fabricating facilities of the Contractor at any time when the work is in progress. All shop and field materials and workmanship shall be subject to inspection by the Architect and his representatives at all times. Such inspections do not relieve the Contractor from obligations to provide materials conforming to all requirements of the Contract Documents.

E. The Contractor, by commencing the work of this Section, assumes overall responsibility, as part of his warranty of the work, to assure that all assemblies, components and parts shown or required within the work of this Section, comply with the Contract Documents. The Contractor shall further warrant:

1. That all components, specified or required to satisfactorily complete the installation, are compatible with each other and with the conditions of installation and expected use.

2. The overall effective integration and correctness of individual parts and the whole of the system.

3. Compatibility with adjoining substrates, materials and work of other trades.

4. There shall be no premature material failure due to improper design and fabrication of the stone. All materials are to fully perform to their normal life expectancy.

5. Each piece of stone shall be subject to the Architect's approval, and any piece or pieces which may be rejected after having been set shall be carefully cut out and replaced with new suitable stone without delay, and without cost to the Owner. Any piece or pieces damaged in the removal and resetting of defective pieces shall also be removed, and suitable, approved pieces provided and set.

F. Architect's inspection of the stone does not relieve the Contractor from his responsibility to provide all stonework in accordance with the approved samples and shop drawings.

G. Examination Criteria: All examinations, selections and approvals shall be for the purpose of achieving a final appearance of stone with the greatest possible uniformity, and will be based upon the following criteria:

1. Color within approved, pre-selected color ranges and finish.

2. Sequence matching of adjacent stone units, as approved by the Architect.

3. Only one source of each type of stone shall be used throughout the work. Stone shall match the type, pattern, color, texture and finish of samples available for inspection in the office of the Architect.

4. Conformance to approved shop drawings and details within specified dimensions and tolerances.

5. Other criteria as specified in Part 2 - Products, herein.

1.6 SUBMITTALS

A. Shop Drawings: Prior to construction of mock-up, submit shop drawings for the fabrication and installation of all work and associated components. Include:

1. Wall elevations at 1/4" scale, typical unit elevation at 1" scale.

2. Show details of all conditions for every member, joint, anchorage and provision for expansion and contraction and joint treatment.

3. Include coordination details for related and adjoining work, insert drawings and erection diagrams. Show relative layout for all adjacent walls, beams, columns and slabs, all correctly dimensioned.

4. The Architect shall consider alternative stone anchor systems in lieu of system shown on drawings. Contractor shall submit complete engineering calculations as specified herein for alternative system, as well as any cost savings achieved.

5. Stone: Submit complete cutting and setting drawings to Architect for approval. Shop sizes, shapes, thicknesses, jointing, anchoring, connection with other work, typical and special anchoring details, supports, dimensions, setting numbers, and color range for each piece of stone. Clearly indicate dimensions for locating slots in stone and for locating inserts to be built into concrete and masonry. Do not fabricate any stone (except for samples) until shop drawings have been approved by the Architect. Shop drawings shall be based upon actual field measurements to determine exact dimension of each stone piece and anchorage required. Dimensions shown on shop drawings shall be actual field dimensions.

B. Manufacturer's Data

1. Submit copies of manufacturer's specifications and installation instructions for each stonework accessory required. Include data substantiating that materials comply with specified requirements. Indicate that installer has received copy of manufacturer's instructions.

2. Manufacturer's instructions for handling and storage at job site; installation and protection of stone. Indicate that erector of stonework has received a copy of each instruction.

C. Samples: Submit samples of all materials to be encompassed in the work in size and quantity, as required by the Architect. These will include, but not be limited to, samples of:

Each type of Stone	Two sets of 1' x 1' indicating full Typical range of color and texture
Each type of Stone, Corners, Special Shapes	1'-0" x 1'-0" approx. w/all edgework, and adhesive joinery, ea. type
Fastenings, Devices, Anchors, Shims, and Setting pads	Each type
Grout	Color

D. Slab Review: After acceptance of Initial Stone Samples, visit by Architect and Owner for review and approval of stone slabs prior to finishing and including some finished slabs and including initial visual mock-up as noted on the drawings.

1.7 FABRICATION TOLERANCES

A. Conform to the following dimensional tolerances; all tolerance measurements are + or – unless otherwise noted.

1. Marble and Limestone: 1/32" in length, width and thickness (at exposed edges).

2. Granite, Slate, and Quartz-Based Stone

   a. Smooth Face. 1/8" in length and width. 1/16" at exposed edges.
   b. Sawn Face. 1/8" in length and width and exposed edges.
   c. Thermal, course stippled finishes and natural cleft slate. 1/8" in length and width. 3/16" at exposed edges.

3. Natural Stone Veneer Panels: 1/16" in length and width.

4. Square: One half the joint size, but not more than 1/16" for stones with the largest edge dimension not greater than 39".

5. Flatness Tolerance (all tolerance measurements are + or - and measured along a 4-foot dimension in any direction): Smooth finished stones - 1/16".

6. Joint Size: Joint width between stone panels shall be 1/16"; 0 tolerance. Joints to materials other than stone shall be 1/8" wide.

1.8 PERFORMANCE REQUIREMENTS

A. Structural Requirements: The work, as erected, shall be designed to withstand a lateral force of 5 psf applied over field surface normal to face of stone without failure of stone or anchors.

B. Methods and fabrication and assembly (except as specified herein) shall be at the discretion of the Contractor provided that the visible architectural effect is not changed, the work of other Contractors is not affected and the strength qualities, as demonstrated by engineering calculations are not reduced.

C. Remedial measures, which may be necessary on the building, shall maintain standards of quality and durability and are subject to approval by the Architect.

D. Anchors: Adequate number and size of anchors shall be provided to satisfy the load requirements and design criteria.

E. Variations in Structure: The work shall be designed to accommodate variation in location of surrounding and supporting work, as defined as allowable variations in the work, as specified in other Sections of the project Specifications.

1.9 CODES AND STANDARDS

A. All work shall be performed in accordance with the City Of New York Building Code, or the requirements of this Specification, whichever are more stringent.

B. Stone Cladding System shall conform to, but not be limited to, the following codes and standards as a minimum:

1. National Building Granite Quarries Assoc. (NBGQA).

2. American National Standards Institute (ANSI).

3. Marble Institute of America (MIA) “Dimension Stone Design Manual”, latest edition.

4. Building Stone Institute (BSI).

5. American Society for Testing and Materials (ASTM).

1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect stone during storage and construction against moisture, soiling, staining, and physical damage.

B. Handle stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials. Lift with wide-belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides.

C. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around stone.

D. Protect mortar materials and stonework accessories from weather, moisture, and contamination with foreign materials.

1.11 JOB CONDITIONS

A. Installer must review installation procedures and coordination with other work with Contractor and other subcontractors whose work will be affected by stonework.

1.12 PROTECTION

A. Protect adjacent surfaces from damage. Protect exposed surfaces of stone units from damage or defacement. Prevent materials used for installing work of this Section from staining or damaging the exposed surfaces of stone units or the exposed surfaces of the adjoining construction.

B. Protect all stonework from other materials that will cause staining or defacement. Stone subject to damage after setting shall be properly covered or protected.

C. No lumber or other material liable to stain or deface the stone shall be used.

1.13 GUARANTEE

A. Unless stated otherwise in these Specifications, guarantee shall state that all work is in accord with drawings and Specifications, as amended by any changes thereto authorized by the Architect, free from defects in materials and workmanship for a period of five (5) years from date of acceptance of the work by the Owner. Contractor shall agree to repair or replace defective materials and workmanship during the guarantee period at no additional cost to the Owner.

B. Defective materials and workmanship are hereby defined to include evidence of abnormal deterioration, aging, structural failure of components resulting from exposure to normal load and forces, failure of operating parts to function normally, sealant failures, deterioration or discoloration of finishes in excess of normal aging, and failure to fulfill other specified performance.

C. Contractor and respective subcontractors shall be responsible for damage to the building and furnishings occasioned by defective materials or workmanship or damage as part of repairs to the interior stone cladding.

D. The guarantee, the enforcement or lack of enforcement thereof, shall not deprive the Owner of other actions, rights or remedies available to him. Guarantee shall be in form approved by the Architect.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stone Quality and Characteristics: All stone shall be of best quality, sound stock, and carefully selected; uniform in color, pattern, markings, texture and finish; and free from defects impairing strength, durability or appearance such as cracks, seams, mineral stains, flaws, or imperfections which are not a normal characteristic of the stone. Patching or filling of chips or cracks is not permitted. Delivered stone shall match the approved samples, and any stone not matching the approved sample may be rejected by the Architect as unfit. Size and thickness of stone units as indicated on drawings.

1. Stone shall be as indicated on the Materials List.

2. Finish: Stone shall have a honed finish on all exposed surfaces; concealed surfaces may be sawn. Edges to receive grout or sealant shall be sawn.

B. Quarrying Supervision

1. Quarrying shall be supervised and coordinated by the stone fabricator to insure that the as-quarried block orientations will yield finished material with characteristics as described herein.

2. All stone shall be cut from matched blocks. Matched blocks shall mean blocks extracted from a single bed of stratum in the quarry. The use of blocks chosen at random, though similar in general character and color to that of the approved stone shall not be permitted, except by written permission of the Architect.

C. Examinations

1. Examination at the Quarry: Quarried blocks shall be made available for inspection by the Architect at his request. Provide multiple samples of stone that show the required range, then after acceptance of stone the architect is to visit stone slabs for examination.

2. Examination at the Fabrication Plant: Production units shall be made available for inspection by the Architect at his request. To this end, the Contractor shall, after approval of final shop drawings, advise the Architect when production has begun and of the earliest possible opportunity to inspect a representative sampling of production work.

3. Contractor shall provide lighting that is sufficient in intensity and color range to permit an adequate examination to the satisfaction of the Architect.

D. Visual Criteria for Stone: All examinations, selections, and approvals shall be for the purpose of achieving a final appearance of stone with greatest possible uniformity, and will be based upon the following criteria:

1. All stone shall be of sound stock and uniform texture, and shall be free from holes, seams, shakes, clay pockets, spalls, stains, starts, and other defects which would impair the strength, durability, and appearance of the work, as determined by the Architect.

2. Inherent variations characteristic of the stone and the quarry from which the stone is to be obtained shall be brought to the attention of the Architect at the time the samples are submitted for approval, and shall be subject to approval of the Architect.

3. All stone shall be selected for background color, veining, marking and matching, shall run in even shades, and shall be set accordingly.

E. Physical and Mechanical: All design of stone support system shall be based on the mechanical and physical properties of the selected stone. Performance data for these properties shall have been derived

from tests by an independent engineering laboratory acceptable to the Architect, and shall be furnished by the contractor to the Architect for the stone selected. This performance data shall include:

1. Absorption by Weight (ASTM C 97).
2. Flexural Strength (ASTM C 880).
3. Compressive Strength (ASTM C 170).
4. Modulus of Rupture (ASTM C 99).

2.2 ACCESSORY MATERIALS FOR STONEWORK

A. Mortar Materials

1. White Portland Cement: ASTM C 150, Type 1 or Type II, non-staining. Cement shall in no case contain more than 0.03% by weight of soluble alkali (calculated as Na_2O). Submit mill certificates of cement and certified analysis from an approved testing laboratory.
2. Sand: ASTM C 144, except graded with 100% passing No. 16 sieve, non-staining.
3. Hydrated Lime: ASTM C 207, Type S.
4. Water: Potable, clear and free of deleterious materials which would impair the quality of the mortar.
5. Color Mortar Pigments for Joint Mortar: Natural and synthetic iron and chromium oxides, compounded for use in joint mortar/grout mixes. Use only pigments that have proved through testing and experience to be satisfactory for use in Portland cement mixes with latex admixtures. Provide integral, non-fading colorant made by Davis Colors, Scoffield, or approved equal color selected by the Architect..
6. Plaster of Paris: ASTM C 59.
7. Shims: Hard plastic or stainless steel.

B. Stone Support

1. Manufacturer and General: Stone support systems, anchors and accessories shall be manufactured by a company specializing in the design and fabrication of stone approved by the Architect. Provide all fastening devices, wire anchors, support angles, relieving angles, anchors, coping anchors, dowels, cramps, bolts, nuts, shims, expansion shields, flashing, etc., necessary to properly secure stone walls to the structure.
2. Stainless Steel to be used for stone supports shall conform to the following:
    a. Sheet, Bar and Plate: AISI Type 304 non-magnetic, conforming to ASTM A 666.
    b. Fasteners, Anchor Bolts, Nuts and Washers: AISI Type 304 non-magnetic, ASTM A 167.
3. For wire anchors, provide No. 8 gauge half hard yellow brass wire anchors.

2.3 FABRICATION

A. All stone work shall be executed by mechanics skilled in the trade. All stone shall be well-cured and seasoned before cutting. Cut stone units with bed, unless otherwise approved by the Architect.

B. Stone shall be accurately cut to sizes, shapes, profiles and dimensions. There shall be no deviation from jointing.

C. Exposed surfaces and edges of stone units shall be free from cracks, broken corners, chipped arrises, scratches or other defects affecting appearance. Patching or filling not permitted.

D. Backs of stone units shall be sawn to true planes, parallel to face plane.

E. Cut stone units full and true on faces, reveals, beds, joint and top, to the full dimensions required by drawings. All edges shall be straight and true with sharp and true arrises. All stone shall fit together accurately.

F. Make faces of stone units in same plane flush at joints. All finished surfaces shall be true in line and face.

G. Sawn surfaces and edges shall be cleaned of all rust stains and iron particles.

H. No patching or use of stone with chipped edges or faces shall be permitted.

I. Thickness: Provide stone panel of thickness shown on drawings. Saw-cut back surfaces which will be concealed in the finished work. Provide greater stone thickness than shown where thickness shown is insufficient for the sizes or where extent of cut-outs shown decreases effective strength of the remaining material, or for proper and sufficient anchorage, suitable and adequate bearing areas for surfaces.

J. Adhesive Bonded Units

1. Adhesive shall be a 2-component epoxy resin designed specifically for structural bonding of stone units.

2. Prepare stone, mix adhesive and fabricate bonded units in accordance with the recommendations of the NBGQA and adhesive manufacturer's instructions. Color shall match stone.

3. Adhesively bonded units shall be fabricated with a non-continuous stone liner reinforcing that is mechanically secured to both face stones and stainless steel dowels. Size and spacing shall be designed to achieve a mechanical support should the adhesive fail.

4. Finish joints shall be smooth and without staining or excess adhesive on exposed surfaces. Remove adhesive from exposed joints after hardening and leave finish surfaces without damage, or impairment of the polished finish.

2.4 CUTTING, DRILLING AND FITTING

A. Provide holes and sinkages required for anchors, dowels, other devices required to support and/or suspend stone, and to accommodate other items which connect to or penetrate the stone.

B. Include all cutting, drilling and fitting of stone work required to accommodate the work of other trades. In cutting and fitting, carefully cut and grind edges to a neat tight fit. Do cutting in such manner so as not to impair strength or appearance of stone. Use physical templates for all cutting and drilling; obtain required templates from proper trades.

C. Refer to Article 1.7 herein for fabrication tolerances.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where interior stone cladding is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

B. Review installation procedures and coordinate with other work, and with other trades whose work will be affected by the stonework.

C. Advise other trades of requirements relating to their placement of any inserts which are to be used for anchoring and supporting of stonework.

3.2 INSTALLATION

A. Sample Section of Interior Stone Cladding

1. Prior to general installation of interior stone cladding, install a section of the wall (used as "control section") in accordance with final approved shop drawings. Architect shall be informed of time and place of such installation of control section.

2. Obtain Architect's acceptance of visual qualities of control section before start of general installation. Replace unsatisfactory work, as directed, until acceptable to the Architect. Retain control section in permanent work as a standard for judging completed work.

B. Qualification of Workmen: All work shall be performed by skilled workmen, especially trained and experienced in this type of work.

C. Lines and Grades: Benchmarks for elevations and building line offset marks for alignment shall be established on each floor level by the Contractor, who shall be responsible for their accuracy. Should any error be found in their location, the Installation Contractor shall so notify the Contractor in writing and installation work shall not proceed in the affected areas until the errors have been corrected.

D. Workmanship: All parts of the work shall be erected plumb and true, in proper alignment and relation to established lines and grades, and as shown on approved shop and/or erection drawings.

E. Erection Tolerances

1. Permissible dimensional tolerance in the building frame and/or work surrounding or supporting the work of this Section are stated in the appropriate Trade Sections of these Specifications.

2. The work shall be designed to accommodate all tolerances and anticipate dead and live load movement, creep, sway and torsion of the structure without any harmful effects.

3. Stone erection tolerances shall be as follows:

a. Joint width 1/16", $\pm$ 0" tolerance.
b. Variation from Plumb: For lines and surfaces of walls and arrises, do not exceed 1/8" in 20 ft. max. For external corners, expansion joints and other conspicuous lines, do not exceed 1/8" in any story or 20 ft. max.
c. Variations from Level: For grades shown for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/8" in any bay or 30 ft. max.
d. Variation of Linear Building Line: For position shown in plan and related portion of grid lines, walls and partitions, do not exceed 1/8" in any bay or 30 ft. max.
e. Offset at Joints: Do not exceed plus or minus 1/32".

F. Do not use stone units with chips, cracks, voids, stains or other defects which might be visible in the finished work. Patching or hiding defects in stone will not be permitted.

G. Clean stone before setting by scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives. If not thoroughly wet at time of setting, drench or sponge stone. Do not wet expansion or control joint surfaces.

H. Shims used to maintain joint width must be removed prior to pointing.

3.3 SETTING STONE

A. Mortar

1. 1 part non-staining cement with color ingredient.

2. 2 parts clean selected sand to be compatible with the colored cement.

3. Lime to make as still a mix as can be worked.

4. Water as required.

B. Mixing

1. Mix cementitious materials, admixtures, and aggregate with the proper amount of water consistency which will result in a homogeneous, still and plastic mix.

2. Mix mortar in small batches by approved mechanical mixes. Monitor volume of materials per batch carefully.

3. Retempering of mortar will not be permitted, and mortar that has been allowed to stand more than one or two hours shall not be used. Mortar shall be mixed and kept tempered so that it will, at all times, contain as much water as it is able to carry.

4. Setting grouts and mortar work shall be prepared for use in strict conformance with the recommendations and instructions of the manufacturer.

C. Anchors

1. A minimum of 2 anchors shall be required on all pieces up to 2 square feet in area.

2. A minimum of 4 anchors shall be required on all pieces up to 20 square feet in area.

3. A minimum of 2 additional anchors shall be required on each additional 10 square feet.

D. Set stone and install stone support systems in accordance with drawings and final shop drawings for stonework. Provide anchors, supports, fasteners, and other attachments shown, or necessary to secure stonework in place. Shim and adjust accessories as required for proper setting of stone. Completely fill holes, slots and other sinkages for anchors, dowels, fasteners, and supports with epoxy adhesive/grout during setting of stones.

E. Erect walls plumb and true with 1/16" joints, unless otherwise shown on shop drawings, uniform in width and accurately aligned.

F. Joints: Fully butter with mortar and tool flush. Maintain an even joint between units 1/16" max. Surplus grout shall be immediately cleaned from the face of the stone. Use colored mortar as directed by the Architect.

G. Cleaning: After final cleaning of stone, repoint any open joints with grout.

H. Where stone is supported by wire anchors, conform to the requirements noted above and the following:

1. Back-up standing stone required to be set against masonry with Plaster of Paris spots.

2. Place spots not over 16" apart in both directions. Securely anchor stone to structural backing with sufficient number of wire anchors properly wedged into holes cut or drilled into edges of stone. Embed wire anchors in mortar used for spots. Loop or hook and extend anchors into holes cut into masonry backing.

3. Thoroughly fill holes with mortar used for spots. Make anchor hole in backing larger at back than in front so that, when filled, it will form a plug which cannot be pulled loose.

I. Anchors or dowels shall not show in finished work.

J. Wet masonry surfaces before applying anchors and Plaster of Paris spots or Portland cement spots.

3.4 PROTECTION OF STONEWORK

A. Prevent materials used for installing work of this Section from staining or damaging the exposed surfaces of stone units or the exposed surfaces of the adjoining construction. Immediately remove mortar, grout or other detrimental materials from exposed surfaces of stone or adjoining construction.

B. Protect all stonework from other materials that will cause staining or defacement. Stone subject to damage after setting shall be properly covered or protected.

C. Provide additional protection for finished work such as exposed edges, corners, and all other stone liable to physical injury or staining. Protection shall include but is not limited to non-staining approved coverings, and clean non-staining wood boxing. All fastenings or hold-back devices shall be stainless steel. Fastening to stone joints is prohibited.

D. At completion of construction work, remove all temporary protection installed as work of this Section.

E. After installation, protect stonework from damage during subsequent construction activities.

3.5 ADJUSTING, CLEANING, AND REPAIRING

A. Examine all work and repair all damage. Clean soiled or stained surfaces. In the event damage is irreparable, or soiled or stained surface cannot be cleaned, then remove and replace such items at no additional cost to Owner.

B. Remove and replace stonework of the following description:

1. Defective, broken, chipped, stained, or otherwise damaged stone units installed as work of this Section.

2. Unfilled or defective joint.

3. Stone joints not matching approved samples and mockups.

C. Replace in manner that results in stonework matching approved samples and mockups.

D. In-Progress Cleaning: Clean stonework as work progresses. Remove mortar fins and smears before tooling joints.

E. Final Cleaning: After setting mortar and, as applicable, mortar is thoroughly set and cured, clean stonework as follows:

1. After completion of any repair work, clean exposed surfaces of all stone surfaces and units installed as work of this Section with clean water and stiff fiber brushes until all dirt, stains, efflorescence, mortar, and other defacements are removed. Use cleaner and procedures recommended by stone

quarry and stone fabricator and approved by Architect. Do not use wire brushes, metal scrapers or acids. Protect adjacent surfaces from damage during cleaning operations.

2. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

3. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of each area or element of stonework.

END OF SECTION

SECTION 097722

PERFORATED WOOD ACOUSTICAL WALL PANELS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the wall perforated wood acoustical wall panels as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Micro-perforated wood-veneered panels.
2. Sound absorbing blanket.
3. Hardware system as required for attachment to substrate.
4. Coordination with all trades having elements that attach to, penetrate through, or are concealed behind the wood panels of this section.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000.

B. Gypsum Drywall - Section 092900.

1.4 REFERENCES

A. ASTM C 423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2000.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2000a.

1.5 PERFORMANCE REQUIREMENTS

A. Acoustical Absorption: Perform testing in accordance with ASTM C 423, Type A mounting method unless otherwise specified.

B. Flame Spread Rating: Provide all components with Class A flame spread rating when tested in accordance with ASTM E 84, unless otherwise specified.

1.6 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

4. Independent testing agency test reports.

B. Shop Drawings: Submit shop drawings of all wood panel work specified and indicated on the drawings. Shop drawings shall indicate room plans and elevations at 3/4" equals 1'-0" scale and typical construction details at 3" equals 1'-0" scale. Shop drawings shall indicate all materials, thicknesses and finishes.

C. Samples for Initial Selection: For each product specified, two complete sets of color samples representing manufacturer's full range of available colors and patterns.

D. Samples for Verification: For each product specified, two samples, minimum size 6 inches square, representing actual product, color, and patterns.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 years of experience in producing wall acoustic panels of the types specified herein.

B. Installer Qualifications: Acceptable to the manufacturer of the wall acoustic panels being installed.

C. Source Limitations: Obtain wall acoustic panels through one source from a single manufacturer.

D. Mock-Up: Upon request by the Architect, provide a mock-up for evaluation of installed appearance 9’-0” tall x 4’-0” wide.

1. Do not proceed with remaining work until Architect approves workmanship and appearance.

2. Approved mock-up may remain as part of the work.

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect all products from moisture during shipment, storage, and handling.

B. Store products in manufacturer's unopened packaging until ready for installation.

1. Store materials flat, in dry, tempered, well-ventilated space.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install wall acoustic panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Minimum Requirements: 50° - 85° F; 25% - 55% Relative Humidity.

1.10 WARRANTY

A. Special Warranty: Standard form in which Installer agrees to repair or replace components of wall acoustic panels that fail in performance, materials, or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUAFACTURERS

A. SoundPly Wood Perforated Panels from Navy Island, West St. Paul, MN 651-451-4454, https://www.soundply.com/

B. Or approved equal.

2.2 MATERIALS

A. SOUNDPLY RF M51 Acoustic Wall Panels for interior installation 2" (51mm) thick acoustical or decorative panels as follows: An architectural face material as indicated on finish schedule laminated to a rigid backer. Face and backer thickness not less than 1.5mm (0.060"), to provide long-term color stability of face material, in addition to adequate impact resistance for the panel. The core of the panels shall be comprised of a Class A material and a balancing backer sheet.

B. Acoustical Panels: Panels will be furnished with a perforated face consisting of 0.5mm (0.02") diameter holes in an offset pattern. The perforations must be clean, without rounded edges or grain pull out between perforations. A minimum of 99.5% of the perforations must be acoustically functional, providing unobstructed passage into the open cavities of the core. Perforations must maintain consistent diameter through the face and backer, with no tapering or roughness. A fiberglass-reinforced polymer sheet, designed to balance the face, will be applied to the back of the panels, and will vary based on the face sheet specified.

C. Panels Edge Treatment: Panels will be edge banded with the matching materials and finish, or as specified by the architect, to match or contrast with the panel face.

D. Panel Weight: Panels will not exceed 2.3 lbs/ft^2 (11.3 kg/m^2) for 2" (51mm) thick panels.

E. Panel Sizes: Panels are custom sized based on field dimensions up to a maximum of 1525mm (60") by 3660mm (144"). Panels longer than 3048 mm (120") are limited by veneer availability.

F. Flame Resistance: Class 1(A) rating based on ASTM E-84 Standard Test Method for Surface Burning Characteristics in Building Materials. Some veneer species and other face materials may not achieve an overall Class 1(A) rating. Check with local building codes for requirements or exemptions.

G. NRC Performance: Noise Reduction Coefficient for acoustical panels to be no less than 1.00 using Type F6 direct mount without additional acoustical insulation.

H. STC Performance: Sound Transmission Class to be no less than 37 using ASTM Test Method E336.

I. Panel Stability: Linear contraction or expansion to not exceed 0.4% maximum variation in width or height per ASTM D1037.

J. Finish for Veneer-Faced Panels

1. Veneer Species: White oak.

2. Cut: Quarter sawn.

3. Grade: Trugrade 90.

4. Matching Veneer Leaves: Book matched.

5. Matching Between Panels: Center balanced.

6. Finish: Stained to match Architect's sample.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where acoustical wall panels are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install wall acoustic panels in accordance with manufacturer' written instructions where indicated on drawings, scribed to fit adjoining work accurately at borders and at penetrations.

1. To avoid damage, acoustic panels should not be directly hammered.

B. Frame Materials: Install track level, plumb and securely fastened to supporting substrate.

C. Core Materials: Mechanically attach securely to supporting substrate.

1. Core material to be Sintered Resin-Reinforced Glass Wool fit tight, free from bumps and protrusions.

a. Use of adhesives is unacceptable.

3.4 CLEANING

A. Clean wall acoustic panels, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

3.5 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure wall acoustic panels are without damage or deterioration at time of Substantial Completion.

B. Replace wall acoustic panels that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION

SECTION 098413

ACOUSTICAL WALL PANELS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the acoustical wall panels as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Acoustical absorption panels wrapped in selected fabric.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000.

B. Gypsum Drywall - Section 092900.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualification: At least 5 years' experience fabricating and installing comparable work, employing skilled mechanics under competent supervision for all phases of the Work.

1.5 SUBMITTALS

A. Shop Drawings/Product Data

1. Base drawings on field measurements.

2. Show dimensioned wall elevations with seam and joint locations, cutout sizes and locations, anchor locations, relation to adjacent work; large scale joint and mounting details; materials type, weight/thickness, design, color; and other data necessary to fabricate and install work and coordinate work with affected trades.

B. Samples: Two 12" x 12" (minimum) panels in selected finish, showing seam, edge and cutout conditions.

C. Certification

1. Acoustical Performance: Certified reports of acoustical performance tests conducted and/or witnessed by a recognized, independent, testing agency. Tests shall have been done by specified methods or recognized equivalent. Sound absorption tests shall be not more than three years old. Reports on earlier tests are acceptable if it can be established to the Architect's satisfaction, that they are valid indications of compliance with Project requirements.

2. Fire Hazard: Evidence of compliance with regulatory agency and specifications requirements.

D. Cleaning and Maintenance Instructions: Recommendations for Owner maintenance and cleaning per Section 017300 requirements. Identify cleaning/spotting products generically or by trade name.

E. Manufacturer Qualifications: List comparable installations with 3-year (minimum) service histories. Describe installations and give Owner/building manager names and addresses.

1.6 REFERENCES

A. ASTM C 423 Test for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

B. ASTM E 84 Test for Surface Burning Characteristics of Building Materials.

1.7 DELIVERY, STORAGE AND HANDLING

A. Allow materials to become acclimated to Project conditions before installation if necessary to prevent sag and distortion during service life.

1.8 PROJECT CONDITIONS

A. Work areas shall be at or near ambient occupancy temperature and relative humidity.

B. Painting, dust-raising activities, and work that introduces dampness shall be completed.

PART 2 PRODUCTS

2.1 GENERAL

A. Fabricate panels to sizes and configurations indicated; attach facing materials to cores to produce installed panels with visible surfaces fully covered and free from waves in fabric weave, wrinkles, sages, blisters, seams, adhesive or other foreign matter.

1. Fabricate back mounted panels in factory to exact sizes required to fit wall surfaces based on field measurements of completed substrates indicated to receive acoustical wall panels.

2. Where radius corners are indicated, attach facing material so there are no seams or gathering of material.

B. Dimensional Tolerances of Finished Units: Overall height and width of panels, plus or minus 1/16".

C. Sound Absorption Performance: Provide acoustical wall panels with minimum noise reduction coefficients (NRC) indicated, as determined by testing per ASTM C 423 for mounting type specified under individual product requirements.

2.2 FABRIC WRAPPED WALL PANELS.

A. Manufactured Units: "Kinetics HardSide" acoustical panels by Kinetics Noise Control.

1. Thickness: 1 inch and 2 inches, as scheduled.

2. Size: As indicated on Drawings.

3. Core: 1-inch thick fiberglass, 6 - 7 pcf density, with bonded facing layer of 1/8 inch thick, high-density, impact-resistant fiberglass.

4. Edge Detail: As selected by Architect.

5. Facing: As selected by Architect.

6. Sound Absorption (ASTM C423): NRC 1.00 minimum.

7. Mounting Accessories: Manufacturer's standard as required for complete installation.

B. Fabrication: Wrap panel edges and return facing fabric 1 to 2 inches on back of panel. Secure fabric with adhesive applied to edges and back of panel only.

C. Colors, Textures, and Patterns: As selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where acoustical wall panels are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. General: Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, scribed to fit adjoining work accurately at borders and at penetrations. Comply with panel manufacturer's printed instructions for installation of panels using type of mounting accessories indicated or, if none indicated, as recommended by manufacturer.

B. Construction Tolerances

1. Variation from Plumb and Level: +/- 1/16".

2. Variation of Joints from Hairline: Not more than 1/16".

C. Remove and replace panels that are damaged and are unacceptable to Architect.

3.3 ADJUSTING AND CLEANING

A. Correct non-complying and damaged/defective Work. Replace work that cannot be satisfactorily repaired.

B. Restretch and reinstall sagging and distorted fabric and correct other defects that occurred during normal service.

C. Carefully and thoroughly clean completed work by vacuuming and/or other means. Remove soil, stains, loose threads.

D. Protect work from soiling and other damage.

END OF SECTION

SECTION 099000

PAINTING AND FINISHING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Prime painting unprimed surfaces to be painted under this Section.

2. Painting all items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coats applied by others.

3. Painting all ferrous metal (except stainless steel) exposed to view.

4. Painting all galvanized ferrous metals exposed to view.

5. Painting gypsum drywall exposed to view.

6. Painting of wood exposed to view, except items which are specified to be painted or finished under other Sections of these specifications. Back painting of all wood in contact with concrete, masonry or other moisture areas.

7. Low VOC paint, as scheduled.

8. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.

9. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers, lighting fixtures, and the like, which are exposed to view through these items.

10. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.

11. Painting of any surface not specifically mentioned to be painted herein or on drawings, but for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, shall be included as though specified.

1.3 RELATED SECTIONS

A. Shop priming is required on some, but not all of the items scheduled to be field painted. Refer to other Sections of work for complete description.

B. Shop Coat on Machinery and Equipment: Refer to the Sections under which various items of manufactured equipment with factory applied shop prime coats are furnished, including, but not necessarily

limited to, the following Sections. All items of equipment furnished with prime coat finish shall be finish painted under this Section.

1. Plumbing - Division 22.

2. Heating, Ventilation and Air Conditioning - Division 23.

C. Color Coding of Mechanical Piping and Electrical Conduits – Divisions 22 and 26.

1. This Color Coding consists of an adhesive tape system and is in addition to painting of piping and conduits under this Section, as specified above.

1.4 MATERIALS AND EQUIPMENT NOT TO BE PAINTED

A. Items of equipment furnished with complete factory finish, except for items specified to be given a finish coat under this Section.

B. Factory-finished acoustical tile.

C. Non-ferrous metals, except for items specified and/or indicated to be painted.

D. Finished hardware, except for hardware that is factory primed.

E. Surfaces not to be painted shall be left completely free of droppings and accidentally applied materials resulting from the work of this Section.

1.5 QUALITY ASSURANCE

A. Job Mock-Up

1. In addition to the samples specified herein to be submitted for approval, apply in the field, at their final location, each type and color of approved paint materials, applied 10 feet wide, floor to ceiling of wall surfaces, before proceeding with the remainder of the work, for approval by the Architect. Paint mock-ups to include door and frame assembly.

2. These applications when approved will establish the quality and workmanship for the work of this Section.

3. Repaint individual areas which are not approved, as determined by the Architect, until approval is received. Assume at least two paint mock-ups of each color and gloss for approval.

B. Qualification of Painters: Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces.

C. Paint Coordination: Provide finish coats that are compatible with the prime coat paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Architect in writing of any anticipated problems using the coating systems as specified with substrates primed by others.

D. All paints must conform to the Volatile Organic Compounds (VOC) standards of prevailing codes and ordinances.

1.6 SUBMITTALS

A. Materials List: Before any paint materials are delivered to the job site, submit to the Architect a complete list of all materials proposed to be furnished and installed under this portion of the work. This shall in no way be construed as permitting substitution of materials for those specified or accepted for this work by the Architect.

B. Samples

1. Accompanying the materials list, submit to the Architect copies of the full range of colors available in each of the proposed products.

2. Upon direction of the Architect, prepare and deliver to the Architect two (2) identical sets of samples of each of the selected colors and glosses painted onto 8-1/2" x 11" x 1/4" thick material; whenever possible, the material for samples shall be the same material as that on which the coating will be applied in the work.

C. Manufacturer's Recommendations: In each case where material proposed is not the material specified or specifically described as an acceptable alternate in this Section of these specifications, submit for the Architect's review the current recommended method of application published by the manufacturer of the proposed material.

D. Closeout Submittal

1. Coating Maintenance Manual: Upon conclusion of the project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual such as Sherwin Williams "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with finish schedule, Area Detail designating where each product/color/finish was used, product data pages, MSDS, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.7 PRODUCT HANDLING

A. Deliver all paint materials to the job site in their original unopened containers with all labels intact and legible at time of use.

B. Protection

1. Store only the approved materials at the job site, and store only in a suitable and designated area restricted to the storage of paint materials and related equipment.

2. Use all means necessary to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste.

3. Use all means necessary to protect paint materials before, during and after application and to protect the installed work and materials of all other trades.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

1.8 EXTRA STOCK

A. Upon completion of this portion of the Work, deliver to the Owner an extra stock of paint equaling approximately ten (10) percent of each color and gloss used and each coating material used, with all such extra stock tightly sealed in clearly labeled containers.

1.9 JOB CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 50 degrees F. and 90 degrees F., unless otherwise permitted by the paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 45 degrees F. and 95 degrees F. unless otherwise permitted by the paint manufacturer's printed instructions.

C. Do not apply paint in snow, rain, fog or mist; or when the relative humidity exceeds eighty-five (85) percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.

D. Painting may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.

PART 2 PRODUCTS

2.1 PAINT MANUFACTURERS

A. Except as otherwise noted, provide the painting products listed for all required painting made by Farrow and Ball or Benjamin Moore as listed on finish schedule. Comply with number of coats and required minimum mil thicknesses as specified herein.

2.2 MATERIALS

A. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer and use only to recommended limits.

B. Colors and Glosses: All colors and glosses shall be as selected by the Architect. Certain colors will require paint manufacturer to prepare special factory mixes to match colors selected by the Architect. Color schedule (with gloss) shall be furnished by the Architect.

C. Coloring Pigment: Products of or furnished by the manufacturer of the paint or enamel approved for the work.

D. Linseed Oil: Raw or boiled, as required, of approved manufacture, per ASTM D 234 and D 260, respectively.

E. Turpentine: Pure distilled gum spirits of turpentine, per ASTM D 13.

F. Shellac: Pure gum shellac (white or orange) cut in pure denatured alcohol using not less than four (4) lbs. of gum per gallon of alcohol.

G. Driers, Putty, Spackling Compound, Patching Plaster, etc.: Best quality, of approved manufacture.

H. Heat-Resistant Paint: Where required, use heat resistant paint when applying paint to heating lines and equipment.

2.3 GENERAL STANDARDS

A. The various surfaces shall be painted or finished as specified below in Article 2.4. However, the Architect reserves the right to change the finishes within the range of flat, semi-gloss or gloss, without additional cost to the Owner.

B. All paints, varnishes, enamels, lacquers, stains and similar materials must be delivered in the original containers with the seals unbroken and label intact and with the manufacturer's instructions printed thereon.

C. All painting materials shall bear identifying labels on the containers with the manufacturer's instructions printed thereon.

D. Paint shall not be badly settled, caked or thickened in the container, shall be readily dispersed with a paddle to a smooth consistency and shall have excellent application properties.

E. Paint shall arrive on the job color-mixed except for tinting of under-coats and possible thinning.

F. All thinning and tinting materials shall be as recommended by the manufacturer for the particular material thinned or tinted.

G. It shall be the responsibility of the Contractor to see that all mixed colors match the color selection made by the Architect prior to application of the coating.

2.4 FINISHES FOR EXPOSED STEEL, EXTERIOR AND INTERIOR

A. High Performance Coating on Exterior Galvanized Ferrous Metals, downpipes and columns, roof deck at canopy

First Coat:	"PittGuard Rapid Coat Epoxy 95-245 Series by PPG, "Series 27WB Typoxy" by Tnemec; "Epoxy Mastic Coating V 160" by Benjamin Moore Corotech or "Recoatable Epoxy Primer 867-45" by Sherwin Williams.
Second Coat:	"Pittthane Ultra 95-812 (Gloss)" or "High Build 95-8800 (Semi-Gloss)" by PPG; "Series 1080 (gloss) Endura-Shield WB" or "Series 1081 (semi-gloss) Endura-Shield WB" by Tnemec; "Acrylic Aliphatic Urethane V 500 (Gloss)" or "V 510 (Semi-Gloss)" by Benjamin Moore Corotech or "Hi-Solids Urethane B65-300/350" by Sherwin Williams.

B. High Performance Coating on Exterior Non-Galvanized Ferrous Metals and Interior Steel Columns and Pipes

Prime Coat:	"Amercoat 68HS Epoxy Zinc-Rich Primer" by PPG; "Series 94-H_2O Hydro-Zinc" by Tnemec; "Organic Zinc Rich Primer V 170" by Benjamin Moore Corotech or "Zinc Clad II Plus Inorganic Zinc Rich Coating B69V212" by Sherwin Williams.
Second Coat:	"Pitt Guard Rapid Coat Epoxy 95-245" by PPG; "Series 27WB Typoxy" by Tnemec; "Epoxy Mastic Coating V 160" by Benjamin Moore Corotech or "Macropoxy 646 Fast Cure Epoxy B58-600" by Sherwin Williams.
Third Coat:	"Pitthane Ultra 95-812 (Gloss)" or "High Build 95-8800 (Semi-Gloss)" by PPG; "Series 1070V (gloss) Fluoronar" or "Series 1071V (semi-gloss) Fluoronar" by Tnemec; "Acrylic Aliphatic Urethane V 500 (Gloss)" or "V 510 (Semi-Gloss)" by Benjamin Moore Corotech or "Hi-Solids Polyurethane B65-300/350" by Sherwin Williams.

C. NOTE: High-performance coating shall be applied on columns, beams and deck at canopy, and elsewhere as indicated/

2.5 OTHER INTERIOR FINISHES

A. Refer to Materials List on the drawings.

2.6 PIPING AND MECHANICAL EQUIPMENT EXPOSED TO VIEW

A. Paint all exposed piping, conduits, ductwork and mechanical and electrical equipment. Use heat-resisting paint when applied to heating lines and equipment. The Contractor is cautioned not to paint or otherwise

disturb moving parts in the mechanical systems. Mask or otherwise protect all parts as required to prevent damage.

B. Exposed Uncovered Ductwork, Piping, Hangers and Equipment: Latex Enamel Undercoater and one (1) coat Acrylic Latex Flat.

C. Exposed Covered Piping, Duct Work and Equipment: Primer/Sealer and one (1) coat Acrylic Latex Flat.

D. Panel Boards, Grilles and Exposed Surfaces of Electrical Equipment: Latex Enamel Undercoater and two (2) coats Latex Semi-Gloss.

E. Equipment or Apparatus with Factory-Applied Paint: Refinish any damaged surfaces to match original finish. Do not paint over name plates and labels.

F. All surfaces of insulation and all other work to be painted shall be wiped or washed clean before any painting is started.

G. All conduit, boxes, distribution boxes, light and power panels, hangers, clamps, etc., are included where painting is required.

H. All items of Mechanical and Electrical trades which are furnished painted under their respective Contracts shall be carefully coordinated with the work of this Section so as to leave no doubt as to what items are scheduled to be painted under this Section.

I. Paint inside of ductwork visible through the diffusers.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 GENERAL WORKMANSHIP REQUIREMENTS

A. Only skilled mechanics shall be employed. Application may be by brush or roller. Spray application only upon acceptance from the Architect in writing.

B. The Contractor shall furnish the Architect a schedule showing when he expects to have completed the respective coats of paint for the various areas and surfaces. This schedule shall be kept current as the job progresses.

C. The Contractor shall protect his work at all times and shall protect all adjacent work and materials by suitable covering or other method during progress of his work. Upon completion of the work, he shall remove all paint and varnish spots from floors, glass and other surfaces. He shall remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and shall leave his part of the work in clean, orderly and acceptable condition.

D. Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide ample in place protection. Upon completion of each space, carefully replace all removed items by workmen skilled in the trades involved.

E. Remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.

F. All materials shall be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.

G. Coverage and hide shall be complete. When color, stain, dirt or undercoats show through final coat of paint, the surface shall be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Owner.

H. All coats shall be dry to manufacturer's recommendations before applying succeeding coats.

I. Do not apply paint behind frameless mirrors that use mastic for adhering to wall surface.

3.3 PREPARATION OF SURFACES

A. General

1. The Contractor shall be held entirely responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coats applied under other Sections of the work. Broom clean all spaces before painting is started. All surfaces to be painted or finished shall be completely dry, clean and smooth.

2. Perform all preparation and cleaning procedures in strict accordance with the paint manufacturer’s instructions and as herein specified, for each particular substrate condition.

3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program the cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

B. Metal Surfaces

1. Weld Fluxes: Remove weld fluxes, splatters, and alkali contaminants from metal surfaces in an approved manner and leave surface ready to receive painting.

2. Bare Metal: Thoroughly clean off all foreign matter such as grease, rust, scale and dirt before priming coat is applied. Clean surfaces, where solder flux has been used, with benzene. Clean surfaces by flushing with mineral spirits. For aluminum surfaces, wipe down with an oil free solvent prior to application of any pre-treatment.

a. Bare metal to receive high performance coating specified herein must be blast cleaned SSPC SP-6 prior to application if field applied primer; coordinate with steel trades furnishing ferrous metals to receive this coating to insure that this cleaning method is followed.

3. Shop Primed Metal: Clean off foreign matter as specified for "Bare Metal." Prime bare, rusted, abraded and marred surfaces with approved primer after proper cleaning of surfaces. Sandpaper all rough surfaces smooth.

4. Galvanized Metal: Prepare surface as per the requirements of ASTM D 6386.

5. Metal Filler: Fill dents, cracks, hollow places, open joints and other irregularities in metal work to be painted with an approved metal filler suitable for the purpose and meeting the requirements of the related Section of work; after setting, sand to a smooth, hard finish, flush with adjoining surface.

C. Gypsum Drywall Surfaces: Scrape off all projections and splatters, spackles all holes or depressions, including taped and spackled joints, sand smooth. Conform to standards established in Section 092900, "Gypsum Drywall."

D. Wood Surfaces: Sand to remove all roughness, loose edges, slivers, or splinters and then brush to remove dust. Wash off grease or dirt with an approved cleaner. Fill all cracks, splits, nail holes, screw holes, and surface defects with putty after the priming coat has been applied. Putty shall be brought up flush with the surface and sanded smooth and touched-up with primer when dry.

E. Touch-Up: Prime paint all patched portions in addition to all other specified coats.

3.4 MATERIALS PREPARATION

A. Mix and prepare painting materials in strict accordance with the manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.

C. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film which may form on the surface into the material. Remove the film and, if necessary, strain the material before using.

D. Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are to be applied. Tint undercoats to match the color of the finish coat; provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.5 APPLICATION

A. General

1. Apply paint by brush or roller in accordance with the manufacturer's directions. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high pile sheep's wool as recommended by the paint manufacturer for material and texture required.

2. The number of coats and paint film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper or rub surfaces with pumice stone where required to produce an even, smooth surface in accordance with the coating manufacturer's directions.

3. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance. Give special attention to insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.

4. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.

   a. "Exposed surfaces" is defined as those areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, etc., are in place in areas scheduled to be painted.

5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint, before final installation of equipment.

6. Paint the back sides of access panels, removable or hinged covers to match the exposed surfaces.

7. Finish doors on tops, bottoms, and side edges the same as the faces, unless otherwise indicated.

8. Enamel finish applied to wood or metal shall be sanded with fine sandpaper and then cleaned between coats to produce an even surface.

9. Paste wood filler applied on open grained wood after beginning to flatten, shall be wiped across the grain of the wood, then with a circular motion, to secure a smooth, filled, clean surface with filler remaining in open grain only. After overnight dry, sand surface with the grain until smooth before applying specified coat.

B. Scheduling Painting

1. Apply the first coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

2. Allow sufficient time between successive coatings to permit proper drying. Do not re-coat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Prime Coats: Re-coat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

D. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage.

E. Touching-Up of Factory Finishes: Unless otherwise specified or shown, materials with a factory finish shall not be painted at the project site. To touch up, the Contractor shall use the factory finished material manufacturer's recommended paint materials to repair abraded, chipped, or otherwise defective surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by the painting and finishing work. Leave all such work undamaged. Correct any damages by cleaning, repairing or replacing, and repainting, as acceptable to the Architect.

B. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.7 CLEAN UP

A. During the progress of the work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.

B. Upon completion of painting work, clean window glass and other paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. At the completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

END OF SECTION

DIVISION 10
SPECIALTIES

SECTION 101400

SIGNAGE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the signage as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Room identification signs.
2. Interior directional and door signage.
3. Fire egress, floor, and other signs required by Code.
4. Site wayfinding signage.

1.3 RELATED SECTIONS

A. Exit signs - Division 26.

1.4 QUALITY ASSURANCE

A. For actual installation of the interior panel signs, use only personnel who are thoroughly familiar with the manufacturer's recommended methods of installation and who are completely trained in the required skills.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

B. Samples: Submit samples of each sign showing finishes, colors, surface textures and qualities of manufacture and design of each sign component, including graphics.

C. Shop Drawings: Submit shop drawings for fabrication and erection of signs. Include plans, elevations, and large scale details of sign wording and lettering layout. Show anchorage and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 PANEL SIGNS

A. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16" measured diagonally from corner to corner, manufactured from aluminum, unframed. Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

B. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, of letters, numbers, and other graphic devices.

C. Tactile Characters: Characters and Grade 2 Braille raised 1/32" above surfaces, in contrasting color.

2.2 FINISHES

A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures, or other characteristics related to appearance, provide colors and surface textures as selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where signs are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install units and components at the locations directed by the Architect, securely mounted with concealed theft-resistant fasteners. Attach to substrates in accordance with the manufacturer's instructions.

B. Install level, plumb, and at the proper height. Cooperate with other trades for installation of sign units to finish surfaces. Repair or replace damaged units as directed by the Architect.

END OF SECTION

SECTION 102226

OPERABLE PARTITIONS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the operable partitions as indicated on the drawings and/or specified herein.

1.3 RELATED SECTIONS

A. Structural steel support - Section 051200.

B. Wood blocking - Section 062000.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and installation instructions for each type of operable partition and installation accessory required.

1. Submit written data on physical characteristics, durability, resistance to fading and flame resistance characteristics.

B. Shop Drawings: Submit shop drawings showing location and extent of operable partitions. Include plans, elevations, and large-scale details of anchorages, and accessory items. Indicate location of each unit with building, conditions at openings, typical for special details, location and installation requirements for hardware and operators.

1. Include methods of installation for each type of support structure and fastening condition.

C. Template Drawings: Submit location template drawings for items supported or anchored by permanent construction.

D. Maintenance Data: Include complete Maintenance Manual.

E. Samples for Initial Selection Purposes: Manufacturer's standard color charts showing full range of colors and materials for each component exposed to view, available for each type of operable partition required.

F. Samples for Verification Purposes

1. 12" square samples of finish selected.

2. Prepare samples form same material to be used for the work.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm (material producer) with not less than three (3) years of production experience, whose published literature clearly indicates general compliance of products with requirements of this section.

B. Installer Qualifications: Firm specializing in operable partition installation with not less than two (2) years of experience in installation of operable partitions similar to those required for this project.

C. Single Source Responsibility: Provide material produced by a single manufacturer partitions and mounting hardware.

D. Physical Properties: Provide operable partitions identical to those tested for the following physical properties, according to the test method indicated.

1. Sound Insulation

a. Rating: NIC of not less than 42, STC of not less than 52.
b. Test Method: ASTM E 336, ASTM C 423.

E. Certification: Submit manufacturer's certificate stating that materials furnished comply with specified requirements. Include supporting certified laboratory testing data indicating that material meets specified test requirements.

1.6 REFERENCED STANDARDS

A. ASTM C 423: Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

B. ASTM E 84: Test Method for Surface Burning Characteristics of Building Materials.

C. ASTM E 90: Method for Laboratory of Airborne Sound Transmission Loss of Building Partitions.

D. ASTM E 557: Practices for Architectural Application and Installation of Operable Partitions.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to project site in original factory wrappings and containers, clearly labeled with identification of manufacturer, brand name, quality or grade, fire hazard classification, and lot number. Store materials in original undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity; laid flat, blocked off ground to prevent sagging and warping. Comply with instructions and recommendations of manufacturer for special delivery, storage, and handling requirements.

1.8 SEQUENCING AND SCHEDULING

A. Sequence operable partition installation with other work to minimize possibility of damage and soiling during remainder of construction period.

1.9 WARRANTY

A. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

1. Warranty period is two (2) years after the date of substantial completion.

1.10 MAINTENANCE

A. Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions. Include precautions against materials and methods which may be detrimental to finishes and performances.

PART 2 PRODUCTS

2.1 OPERABLE PARTITION SYSTEM

A. Operable wall shall be equal to "Acoustiseal 932" manually-operated, paired-panel wall system as manufactured by Modernfold, or equal system made by Panelfold, Kwik-Wall Co., or approved equal.

B. Panel Construction: Panel construction shall be three (3) inches thick, of all steel construction. Panel skins shall be twenty-one (21) gauge steel assembled to a eighteen (18) gauge steel frame. Steel skins shall have laminated backing for rigidity. Top channel assembly shall be reinforced to support the suspension components. "Wrap-around" skin/panel construction shall not require vertical trim on panel faces and shall, with astragal seals, provide a minimum "groove" appearance at the vertical panel joints.

C. Panel Face Finish: Wallcovering selected by Architect.

D. Pass door shall be of same construction and thickness as the panels. Door shall be equipped with friction latch, flush pulls and acoustic seals.

E. Sound Seals

1. Vertical Interlocking Sound Seals Between Panels: Aluminum astragals with tongue and groove configuration in each panel edge. Rigid plastic astragals are not acceptable.

2. Horizontal Top Seals shall be "Modernfold SureSet" automatic operable top seals; manually operated top seals not required or permitted.

3. Horizontal bottom floor seals shall be "Modernfold SureSet" bottom seal:

a. Modernfold SM2 Bottom Seal. Manually activated seals providing nominal 2" operating clearance with an operating range of + 0.50" to -1.50". Seal shall be operable from panel edge or face. Extended seal shall exert nominal 120 pounds downward force to the floor throughout operating range.

F. Suspension System: Provide manufacturer's #30 suspension system, as follows:

1. Suspension Tracks: Track shall be structural aluminum. Static loading of track with brackets at 48" centers shall show no failure of track or brackets at 5,000 lb. point loading at mid-span. Track shall be supported by adjustable steel hanger brackets connected to structural support by pairs of 3/8" diameter threaded rods.

a. Exposed Track Soffit: Track soffit shall be integral to track shape and shall be powder-coated off-white paint finish. Track must accommodate termination of plenum sound barriers on both sides of track.

2. Carriers: One trolley in alternating panels with 3-inch diameter glass-reinforced nylon, all-steel, precision ground, ball-bearing wheels. Steel wheeled or reinforced polymer trolleys on aluminum track are not acceptable. Trolleys shall attach to panels with ½-inch diameter pendent bolt-mounted to welded steel mounting plate.

G. Laboratory acoustical performance of the operable wall shall have been tested in an independent acoustical laboratory in accordance with ASTM E 90 Test Procedures and shall have attained an STC Rating of no less than 52.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where operable partition is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install operable partitions and accessories after finishing operations, including painting, have been completed.

B. Install operable partitions in conformance with drawings, approved shop drawings and using method indicated in strict compliance with manufacturer's written installation instructions; complying as applicable with ANSI E-557, Standard Recommended Practice for Architectural Application and Installation of Operable Partitions.

C. Lubricate bearings and sliding parts; adjust to ensure smooth, easy operation.

D. Match operable partitions for color and pattern by using partitions from cartons in same sequences as manufactured and packaged, if so numbered. Broken, cracked, chipped, or deformed partitions are not acceptable.

3.3 FIELD TESTS

A. Owner will engage an independent testing service to provide in place tests of each operable partition for Noise Isolation Class (NIC). Tests for measurement of noise isolation between rooms will be performed in general conformance with ASTM E-336; NIC rating will be calculated in accordance with ASTM E 413.

B. If any operable partition does not initially meet NIC requirements stated in 1.5, D, installer will be responsible for modifying and adjusting partition assembly as required, after which partition will be retested until compliance is achieved.

1. Owner will pay cost of initial in place field test for each operable partition. Cost of additional testing will be borne by the Contractor.

3.4 CLEANING

A. Clean all operable partition surfaces and clean adjacent surfaces soiled by work of this Section. Avoid use of abrasive cleaners or solutions containing corrosive solvents.

B. Remove debris created by operable partition work from work site.

C. Protect partitions against damage during construction period. Ensure that partitions will be without damage or deterioration at time of substantial completion.

3.5 DEMONSTRATION

A. Demonstrate proper operation and maintenance procedures to Owner's personnel.

END OF SECTION

SECTION 102800

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the toilet accessories as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Mirrors.
2. Grab bars.
3. Toilet accessories and metal-framed mirrors for public areas.
4. Bathroom accessories for Inn.
5. Electric hand dryers.
6. Diaper-changing stations.
7. Shelf and hook strip for Janitor's Closets.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Gypsum Drywall - Section 092900.

C. Ceramic Tiling - Section 093013.

D. Electrical - Division 26.

1.4 QUALITY ASSURANCE

A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

B. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units. Accessories shall be installed at heights in compliance with prevailing Handicapped Code.

C. Products: Unless otherwise noted, provide products of same manufacturer for each type of unit and for units exposed in same areas.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, catalog cuts and installation instructions for each toilet accessory.

B. Setting Drawings: Provide setting drawings, templates, instructions, and directions for installation of anchorage devices in other work

C. Submit schedule of accessories indicating quantity and location of each item.

1.6 PRODUCT HANDLING

A. Deliver accessories to the site ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type or material, manufacturer's name and brand name. Delivered materials shall be identical to approved samples.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 240 or ASTM A 666, Type 304, with polished No. 4 finish, 22 gauge minimum, unless otherwise indicated.

B. Brass: ASTM B 19 flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.

C. Galvanized Steel Sheet: ASTM A 653, G60.

D. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.

E. Mirrors: ASTM C 1503, mirror glazing quality, clear glass mirrors, nominal 1/4" thick.

F. Glass for Shower Doors and Enclosures: Clear, low-iron, tempered glass, nominal 1/2" thick at doors and panels, conforming to ANSI Z97.1. Provide ultra-clear, low-iron "Starphire" glass as manufactured by PPG. Conform to requirements of Section 088000.

2.2 FASTENING DEVICES

A. Exposed Fasteners: Theft-proof type, chrome plated, or stainless steel; match finishes on which they are being used.

B. Concealed Fasteners: Galvanized (ASTM A 123) or cadmium plated.

C. No exposed fastening devices permitted on exposed frames.

D. For metal stud drywall partitions, provide ten (10) gauge galvanized sheet concealed anchor plates for securing surface mounted accessories.

2.3 FABRICATION

A. General: Stamped names or labels on exposed faces of toilet accessory units are not permitted. Unobtrusive labels on surfaces not exposed to view are acceptable. Where locks are required for a particular type of toilet accessory, provide same keying throughout project. Furnish two keys for each lock.

B. Surface-Mounted Toilet Accessories, General: Fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage.

C. Recessed Toilet Accessories, General: Fabricate units of all welded construction, without mitered corners. Hang doors of access panels with full-length stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.

D. Diaper-Changing Table: As manufactured by Koala Kare products, Division of Bobrick; recessed-mounted horizontal unit that opens by folding down from stored position and with child-protection strap. Diaper-changing table shall be engineered to support a minimum of 250 lb. static load when opened.

2.4 MANUFACTURERS

A. Provide products as scheduled on the drawings or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where toilet accessories are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Accessories that are to be partition mounted shall be closely coordinated with other trades, so that the necessary reinforcing is provided to receive the accessories.

B. Furnish templates and setting drawings and anchor plates required for the proper installation of the accessories at gypsum drywall and masonry partitions. Coordinate the work to assure that base plates and anchoring frames are in the proper position to secure the accessories.

C. Verify by measurements taken at the job site those dimensions affecting the work. Bring field dimensions that are at variance with those on the approved shop drawings to the attention of the Architect. Obtain decision regarding corrective measures before the start of fabrication of items affected.

D. Cooperate in the coordination and scheduling of the work of this Section with the work of other Sections so as not to delay job progress.

3.3 INSTALLATION

A. Install accessories at locations indicated on the drawings, using skilled mechanics, in a plumb, level and secure manner.

B. Concealed anchor assemblies for gypsum drywall partitions shall be securely anchored to metal studs to accommodate accessories. Assemblies shall consist of plates and/or angles tack welded to studs.

C. Secure accessories in place, at their designated locations by means of theft-proof concealed set screws, so as to render removing of the accessory with a screwdriver impossible.

D. Unless otherwise indicated, accessories shall conform to heights from the finished floor as shown on the drawings. Where locations are not indicated, such locations shall be as directed by the Architect.

E. All wall-mounted accessories must have supporting wood blocking within walls.

F. Installed accessories shall operate quietly and smoothly for use intended. Doors and operating hardware shall function without binding or unnecessary friction. Dispenser type accessories shall be keyed alike. Prior to final acceptance, master key and one duplicate key shall be given to Owner's authorized agent.

G. The Architect shall be the sole judge of workmanship. Workmanship shall be of the highest quality. Open joints, weld marks, poor connections, etc., will not be permitted. The Architect has the right to reject any accessory if he feels the workmanship is below the standards of this project.

H. Grab bars shall be installed so that they can support a three hundred (300) lb. load for five minutes per ASTM F 446.

3.4 CLEANING AND PROTECTION

A. Upon completion of the installation, clean accessories of dirt, paint and foreign matter.

B. During the installation of accessories and until finally installed and accepted, protect accessories with gummed canvas or other means in order to maintain the accessories in acceptable condition.

C. Replace and/or repair, to the Owner's satisfaction, and at no additional cost to the Owner, installed work that is damaged or defective.

END OF SECTION

SECTION 104416

FIRE EXTINGUISHERS AND CABINETS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the fire extinguishers and cabinets as shown on the drawings and/or specified herein.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

B. Fire suppression systems - Division 21.

C. Fire hose cabinets and valve cabinets - Division 21.

1.4 QUALITY ASSURANCE

A. Provide portable fire extinguishers, cabinets and accessories by one manufacturer.

B. UL-Listed Products: Provide new portable fire extinguishers which are UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for all portable fire extinguishers required. For fire extinguisher cabinets include roughing-in dimensions, and details showing mounting methods, relationships to surrounding construction, door hardware, cabinet type and materials, trim style and door construction, style and materials. Where color selections by Architect are required, include color charts showing full range of manufacturer's standard colors and designs available.

B. Samples: Submit samples, 6" square, of each required finish. Prepare samples on metal of same gauge as metal to be used in the work. Where normal color variations are to be expected, include 2 or more units in each sample showing the limits of such variations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:

1. JL Industries.

2. Larsen's Mfg. Co.

3. Potter Roemer.

2.2 EXTINGUISHERS

A. General: Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standard which comply with requirements of governing authorities.

B. Abbreviations indicated below to identify extinguisher type related to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.

C. Multi-Purpose Dry Chemical Type: UL rated 2-A:10-B:C, 5 lb. nominal capacity, in enameled steel container, for Class A, Class B and Class C fires.

2.3 MOUNTING BRACKETS

A. Provide manufacturer's standard bracket designed to prevent accidental dislodgment of extinguisher, of proper size for type and capacity of extinguisher specified, in manufacturer's standard enamel finish; color to match extinguisher.

2.4 CABINETS

A. Type and Style: Fire extinguisher cabinets shall be metal, recessed, with plexiglass panel, sized to fit within the partition or wall depth. Provide fire rated cabinets within fire rated partitions.

B. Color: Fire extinguisher cabinets shall be factory pre-finished with baked enamel in the colors selected by the Architect from the standard range of colors of the selected manufacturer.

C. Design is based on "Model G-2409-R1" of Larsen's Mfg. Co. Other manufacturers noted herein may substitute their equivalent cabinet upon acceptance by the Architect.

2.5 IDENTIFICATION

A. Identify fire extinguisher in cabinet with lettering spelling "FIRE EXTINGUISHER" painted on door by silk-screen process. Provide lettering on door as selected by Architect from manufacturer's standard letter sizes, styles, colors and layouts.

B. Identify bracket-mounted extinguishers with red letter decals spelling 'FIRE EXTINGUISHER' applied to wall surface. Letter size, style and location as selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where fire extinguishers and cabinets are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install items included in this Section in locations indicated and at heights to comply with applicable regulations of governing authorities.

1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.

2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.

B. Where exact location of cabinets and bracket-mounted fire extinguishers is not indicated, locate as directed by the Architect.

3.3 SERVICE

A. Determine the approximate completion date of the work and then inspect, charge, and tag the fire extinguishers at a date not more than 10 days before or not less than one day before actual completion date of the work.

END OF SECTION

SECTION 105116

WOOD LOCKERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the lockers as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Wood lockers.

2. Trim, closures, anchors and accessories.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: For installation of lockers, use only personnel who are thoroughly trained and experienced in the skills involved and who are completely familiar with the manufacturer's recommended methods of installation.

B. Uniformity: Provide each locker as produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 75 or less.

2. Smoke-Developed Index: 450 or less.

3. Provide products that have been tested in accordance with NFPA 286.

1.5 SUBMITTALS

A. Shop Drawings: Before any materials of this Section are delivered to the job site, submit complete shop drawings, technical data and installation instructions to the Architect. Shop drawing must show method of installation, fillers, trim and accessories. Include locker sequencing information.

B. Samples: Submit 6" x 6" samples of manufacturer's standard finish.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 WOOD LOCKERS

A. Acceptable Manufacturer: Hollman, Inc. (basis of design), or approved equal.

B. Provide single-tier and double-tier wood lockers conforming to AWI Premium grade construction, and as described below:

1. Wood Veneer: AWI premium Grade veneer on MDF core, clear finish, with 2mm edge banding to closely match wood veneer.

2. Door Style: Paneled.

3. Finish: Catalyzed lacquer applied in two coats with hand sanding between coats, sealed with a moisture resistant top coat.

4. Hardware: Number disk, coat rod, two (2) coat hooks, door knobs, pulls and hinges.

a. Hinges: Two (2) heavy duty, steel European concealed hinges with up to 125 degrees of door opening on all doors.
b. Number Disk: 1-1/2" disc with black engraved number routed flush with locker door.
c. Locking: Fabricate lockers to accept combination locks.
d. All hardware shall be provided in architectural bronze finish or approved equal.

C. Locker Box

1. Interior and shelves constructed of 5/8" stain resistant, high impact, high density thermally fused almond colored melamine with particleboard susbstrate.

2. Locker frame constructed of 5/8" particleboard with all exposed edges of locker frame finished with a 2 mm PVC edge banding to closely match locker door.

3. Venting: 1/2" opening between door and frame on locker top and bottom.

D. Doors

1. Flat/Recessed Panel: 3/4" kiln dried solid wood stile and rail with flat/recessed center panel All stile and rail joints are glued together with moisture resistant glue for increased durability. Door edges are rounded. Veneer selected by Architect.

2. Ends and Fillers: Locker end, filler and back panels matching locker door cover exposed sides, backs and intersections.

E. Fabrication

1. Wood lockers shall be fabricated using doweled and glued assembly process.

2. Fabricate locker parts square, rigid and without warp, with the finished faces flat and free of scratches and chips.

3. Machine attachment holes accurate and free of chips. Attach fasteners as standard with manufacturer.

4. Fabricate corners and fillers as required for installation.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where lockers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install lockers at locations shown in accordance with manufacturer's instructions for plumb, level, rigid and flush installation.

3.3 ADJUST AND CLEAN

A. Adjust doors and latches to operate easily without binding. Verify that integral locking devices are operating properly.

B. Touch-up marred finishes, but replace units which cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 108213

EXTERIOR GRILLES AND SCREENS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the exterior grilles and screens as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Mechanical equipment screens.

1.3 RELATED SECTIONS

A. Joint Sealers - Section 079200.

1.4 PERFORMANCE REQUIREMENTS

A. Design Loads: Comply with New York State Building Code for site location and building height.

1. Design to resist ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

2. Design all materials, assembly and attachments to resist snow, wind, suction and uplift loading at any point without damage or permanent set.

B. Structural Design: Prepare structural design calculations for screen framing and attachment to structure including reactions at base supports for verification of roof structure by the Architect.

C. Thermal Movements: Provide screens that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects.

1. Temperature Change (Range): 120 deg. F., ambient; 180 deg. F, material surfaces.

D. All welds shall be performed by an AWS-certified welder. Valid certification shall be provided.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, certified test data, where applicable, and installation instructions for required products, including finishes.

B. Shop Drawings: Submit shop drawings for fabrication and erection of screen units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.

C. Samples: Submit six (6) inch square samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work. Where normal color and texture variations are to be expected, include two (2) or more units in each sample showing limits of such variations.

D. Design Calculations: Submit 3 copies of structural design calculations for structural components and components resisting wind loads with seal and signature of professional engineer licensed in the State of New York.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

1.7 WARRANTY

A. Finish shall be warranted fro a period of 20 years; starting from date of Substantial Completion of the Project.

PART 2 PRODUCTS

2.1 MATERIALS

A. Corruated Panels: Face panel shall be corrugated panels with exposed fasteners, to match existing.

1. Panels shall be fastened to the wall girts with minimum 16 gauge concealed clips and fasteners to allow for unimpeded thermal movement of the wall system. Clips shall be designed to hold panel 1/2" minimum from exterior substrate. Exposed fastened panels are unacceptable.

2. Panels shall be factory fabricated by roll-forming operations to assure consistency and quality of manufacture. Panels fabricated by press brake or folding machine are unacceptable.

3. Metal panels shall be fabricated from zinc-coated steel conforming to ASTM A 653, SS Grade 37, G90 coating, 18 gauge smooth surface texture.

4. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-chromate-fluoride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.

a. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 621.
b. Color shall be as selected by the Architect. Color samples shall be submitted and approved prior to application of color coating.

2.2 MATERIALS

A. Clip Angles: Structural grade stainless steel.

B. Fastenings: Fasteners shall be stainless steel. Provide types, gauge and lengths to suit unit installation conditions.

C. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for installation and elsewhere as required for corrosion resistance. Use stainless steel or lead expansion bolt devices for drilled-in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Sub-Girts: Metal sub-girts shall be formed from eighteen (18) gauge hot dip galvanized steel. Sub girts shall be of the adjustable type and shall conform to ASTM A 653 SQ, Grade 37, G90 coating.

E. All exterior flashing shall be fabricated in the same material, gauge, finish, and color as the exterior profile, unless otherwise noted.

F. Trim Material: Furnish necessary trim in conjunction with the metal wall system, including top, bottom, corner, end wall jamb, sill, head, and coping. Material shall be the same substrate, finish and gauge as the exterior siding. Corners of siding shall be preformed.

2.3 FABRICATION

A. Comply with dimensions, profile limitations, gauges and fabrication details shown and specified.

B. Fabricate components of the system at factory, ready for field assembly.

C. Fabricate components and assemble units to comply with performance requirements specified.

D. Apply specified finishes in conformance with manufacturer's standards, and according to coating manufacturer's instructions.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where exterior grilles and screens are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in masonry construction. Coordinate the delivery of such items to the project site.

3.3 INSTALLATION

A. Locate and place screens units plumb, level and in proper alignment with adjacent work.

B. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.

D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, at Contractor's option.

E. Protect metal surfaces from corrosion by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.

END OF SECTION

THE DESIGN DIFFERENCE
Where the Difference is in the Details

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Poughkeepsie, NY

FINAL GMP SET
December 18, 2020

Section 114000
Foodservice Equipment
Specifications

SECTION 114000

FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment for foodservice facilities indicated on the Drawings.

B. See Division 3 Section "Cast-in-Place Concrete" for the following:

1. Equipment bases.
2. Requirements for slab depressions.
3. Insulated slabs beneath walk-in refrigeration units.

C. See Division 5 Section "Metal Fabrications" for equipment supports.

D. See Division 7 Section "Roof Accessories" for roof curbs and equipment supports.

E. See Division 15 Sections for supply and exhaust fans; exhaust ductwork; service roughing-ins; drain traps; atmospheric vents; valves, pipes, and fittings; fire-extinguishing systems; and other materials required to complete foodservice equipment installation.

F. See Division 15 Section "Commercial Kitchen Hoods" for ventilation hoods.

G. See Division 16 Sections for connections to fire alarm systems, wiring, disconnect switches, and other electrical materials required to complete foodservice equipment installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

C. Coordination Drawings: For foodservice facilities.

1. Indicate locations of foodservice equipment and connections to utilities.
2. Key equipment using same designations as indicated on Drawings.
3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of support for equipment; and utility service characteristics.

D. Samples: For each exposed finish.

E. Operation and maintenance data.

F. Product Schedule: For each foodservice equipment item, include the following:

1. Designation indicated on Drawings.
2. Manufacturer's name and model number.
3. List of factory-authorized service agencies including their addresses and telephone numbers.

G. Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. NSF Standards: Provide equipment that bears NSF Certification Mark or UL Classification Mark certifying compliance with applicable NSF/ANSI standards.

B. BISSC Standards: Provide bakery equipment that complies with BISSC's "Sanitation Standards for the Design and Construction of Bakery Equipment and Machinery."

1. Provide BISSC-certified equipment [with certification verified by a third-party agency].

C. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards and that are UL certified for compliance and labeled for intended use.

D. Steam Equipment: Provide steam-generating and direct-steam heating equipment that is fabricated and labeled to comply with ASME Boiler and Pressure Vessel Code.

E. Regulatory Requirements: Install equipment to comply with the following:

1. ASHRAE 15, "Safety Code for Mechanical Refrigeration."
2. NFPA 54, "National Fuel Gas Code."
3. NFPA 70, "National Electrical Code."
4. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."

F. Seismic Restraints: Comply with SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines," Appendix A, "Seismic Restraint Details," unless otherwise indicated.

G. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Coordination Drawings.

B. Coordinate foodservice equipment layout and installation with other work, including lighting fixtures, HVAC equipment, fire-suppression system components, and utility service connections.

1.5 WARRANTY

A. Refrigeration Compressor Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified warranty period.

1. Failure includes, but is not limited to, inability to maintain set temperature.
2. Warranty Period: Five (5) years from date of Substantial Completion.
3. Other equipment provided shall include a one-year warranty covering parts and labor, plus any extended warranties as normally provided by individual manufacturers. Equipment including refrigeration systems, both self-contained and remote, shall be warrantied by the Contractor on the project for one year as indicated in the preceding sentence. The first day of the first year commences upon the earlier of 1) the date the equipment is put into production at the facility or 2) the date the equipment is accepted by the Contracting Officer.

PART 2 - PRODUCTS

2.1 GENERAL

A. The equipment and its component parts shall be new and unused. All items of standard manufactured equipment shall be current models at the time of delivery. Parts subject to wear, breakage, or distortion shall be accessible for adjustment, replacement, and repair.

B. Means shall be provided to ensure adequate lubrication for moving parts. Oil holes, grease fittings, and filler caps shall be accessible without the use of tools.

C. Plastic nameplates, to identify controls on fabricated equipment and when specified elsewhere, shall be provided of two-ply, 1.6 mm, rigid plastic material which shall be specifically manufactured for engraving such nameplates. The finished nameplate shall be machine engraved with white letters on a black background and shall have edges beveled at a 45° angle. Nameplates shall be attached using an adhesive recommended by the manufacturer of the engraving material

D. The design of the equipment shall be such as to provide for safe and convenient operation. Covers or other safety devices shall be provided for all items of equipment presenting safety hazards. Such guards or safety devices shall not present substantial interference to the operation of the equipment. Guards shall provide easy access to guarded parts.

E. Trim shall not be an acceptable substitute for accuracy and neatness. When trim is required and accepted by Contracting Officer in lieu of rejection of items of equipment, it shall be the Contractor's responsibility to provide same at no additional cost.

F. Unless otherwise specified herein, no material lighter than #20 gauge shall be incorporated into the work. Gauges for sheet iron and sheet steel shall be U.S. Standard Gauges and finished equipment gauge thickness shall not vary more than 5% plus or minus from the thickness indicated below.

GAUGE	THICKNESS	GAUGE	THICKNESS
#10	3.4 mm	#16	1.5 mm
#12	2.6 mm	#18	1.2 mm
#14	1.8 mm	#20	0.9 mm

G. Materials or work described in words which have a well-known and accepted technical or trade meaning shall be held to refer to such accepted meanings.

2.2 MATERIALS

A. Submit a certified copy of the mill analysis of materials if requested by the Contracting Officer.

B. Stainless steel sheets shall conform to ASTM A240, Type 304 Condition A, 18-8, having a No. 4 finish. A No. 2B finish shall be acceptable on surfaces of equipment not exposed to view. Sheets shall be uniform throughout in color, finish, and appearance.

C. Stainless steel tubing and pipe shall be Type 304, 18-8, having a No. 4 finish, and shall conform to either ASTM A213 if seamless or ASTM A249 if welded.

D. Rolled shapes shall be of the cold-rolled type conforming to ASTM A36.

E. Galvanized sheet steel shall conform to ASTM A526; where extensive forming to take place, conform to ASTM A527; conform to ASTM A525, coating designation G115, chemical treatment.

F. Galvanized steel sheets shall be cold-rolled, stretcher leveled, bonderized, and rerolled to ensure a smooth surface.

G. Castings shall be corrosion-resisting metal containing not less than 30% nickel. Castings shall be rough ground, polished, and buffed to bright luster and free from pit marks, runs, checks, burrs, and other imperfections. In lieu of corrosion- resisting metal castings, die-stamped or cast 18-8 stainless steel will be acceptable.

H. Millwork materials shall be free from defects impairing strength, durability, or appearance; straight and free from warpage; and of the best grade for their particular function. Wood shall be well seasoned and kiln dried and shall have an average moisture content of 8%, a maximum of 10%, and a minimum of 5%.

1. Plywood and other woodwork of treatable species, where so required by the code, shall be fire-retardant treated to result in a flame spread rating of 25 or less with no evidence of significant progressive combustion when tested for 30 minutes duration under ASTM E84 and shall bear the testing laboratory mark on a surface to be concealed.
2. Concealed softwood or hardwood lumber shall be of poplar, Douglas fir, basswood, red oak, birch, maple, beech, or other stable wood and shall be select or better grade, unselected for color and grain, surfaced four sides, square-edged, and straight. Basswood may be used where fire-retardant treated materials are required.

3. Plywood for transparent finish shall conform to U.S. Product Standard PS-51-71, Type I (fully waterproofed bond), with architectural grade face veneers of species as specified, free of all pin knots, patches, color streaks and spots, sapwood, and other defects. Plywood designated to have plywood cores shall be of either 5 ply or 7 ply construction. Plywood so designated on the drawings and plywood not otherwise shown shall have a particle board core, cross banding of veneers, and face and back veneers. Particle board cores shall have a 45-pound density, except where the fire retardant treatment requires cores of lesser density.
4. Face veneers shall be matched for color and grain to produce balance and continuity of character. Mineral streaks and other discolorations, worm holes, ruptured grain, loose texture, doze, or shake will not be permitted. Face veneer leaves on each surface shall be full-length, book matched, center matched, and sequence matched. Surfaces shall be sequenced and blueprint matched. Veneers not otherwise indicated shall be plain sliced. Backing veneers for concealed surfaces shall be of a species and thickness to balance the pull of the face veneers.
5. Hardwood plywood for painted surfaces shall conform to U.S. Product Standard PS-51-71, Type I, and shall have sound birch, maple, or other approved close grain hardwood faces suitable for a paint finish.
6. Perforated hardboard shall be a tempered hardboard, 7mm thick, conforming to Federal Specification LLL-B-810B, Type I, SIS, Finish B (primed), Design B (perforated), with 7mm diameter holes spaced on 25mm centers both ways.
7. Plastic laminate surfaces shall be laminated with thermosetting decorative sheets of the color, pattern, and style as selected by the Contracting Officer. Horizontal surfaces shall be laminated with sheets conforming to Federal Specification L-P-508F, Style D, Type I (general purpose), Grade HP, Class 1, 1.6mm thick, satin finish, with rough sanded backs. Vertical surfaces shall be laminated with sheets conforming to Federal Specification L-P-598F, Style D, Type II, (vertical surface), Grade HP, Class 1, non-forming, satin finish, 0.8mm thick or heavier. Surfacing for curved surfaces shall be laminated from sheets conforming to Federal Specification L-P-508F, Style D, Type III (post-forming), Grade HP, Class 1, satin finish. Balance sheets for backs in concealed locations shall be either reject material of the same type and thickness as the general purpose grade facing or may be 0.5mm thick laminate backing sheets conforming to Federal Specification L-P-00508E, Style ND, Type V (backing sheet), Grade HP.
8. Adhesive for application of plastic laminate to wood substrates of counter tops shall be a phenolic, resorcinol, or melamine adhesive conforming to Federal Specification MMM-A-181C and producing a waterproof bond. Adhesive for applying plastic laminate to vertical surfaces shall be either a waterproof type or a water resistant type such as a modified urea- formaldehyde resin liquid glue conforming to Federal Specification MMM-A-188C. Contact adhesive will not be acceptable.
9. Plywood for laminate assemblies shown or specified with plywood core shall be of the 5 or 7 ply construction with sanded close-grain hardwood face and back veneers, laminated with waterproof glue, in thickness shown, conforming to U.S. Product Standard PS-51-71. Particle board for plastic laminate assemblies shown or specified with particle board wood core shall conform to U.S. Products Standard CS-236-66, Type 1 or 2, Grade B (45 pound density), Class 2; except where fire-retardant treatment is required, the density shall conform to the treatment requirements.

I. Sealant, wherever required, for sealing backsplashes to walls, cabinet bodies to concrete or tile bases, roll-in refrigerators to floors, or other types of application shall be Dow-Corning #780 or General Electric "Silastic" or approved equal in either clear or approved color to match surrounding surfaces and applied in accordance with sealant manufacturers' recommendations for smooth, sealed finish.

2.3 FINISHES

A. Paint and coatings shall be of an NSF approved type suitable for use in conjunction with foodservice equipment. Such paint or coating shall be durable, non-toxic, non-dusting, non-flaking, and mildew resistant; shall comply with all governing regulations; and shall be applied in accordance with the recommendations of the manufacturer.

B. Exterior, galvanized parts, exposed members of framework, and wrought steel pipe where specified to be painted shall be cleaned, properly primed with rust-inhibiting primer, degreased, and finished with two (2) coats of epoxy-based grey hammertone paint, unless otherwise specified.

C. Stainless steel, where exposed, shall be polished to a #4 commercial finish. Where unexposed, finish shall be #2B. The grain of polishing shall run in the same direction wherever possible. Where surfaces are disturbed by the fabricating process, such surfaces shall be finished to match adjacent undisturbed surfaces.

D. Galvanized shelving shall not be painted.

E. Fabricated equipment shall be spray coated with plastic suitable for protecting the equipment during transport and installation. The coating shall be easily removable and shall be removed after the equipment installation is complete at the work site or, alternatively, when directed by the Contracting Officer.

F. Exposed surfaces on brass, bronze, or steel shall be plated with chromium over nickel in accordance with Federal Specifications WW-P-541, Paragraph 9.5 and Table 9.4, unless otherwise specified.

2.4 ELECTRICAL AND MECHANICAL REQUIREMENTS

A. Standard UL listed materials, devices, and components shall be selected and installed in accordance with NEMA Standards and recommendations and as required for safe and efficient use and operation of the foodservice equipment without objectionable noise, vibration, and sanitation problems.

1. Provide recognized commercial grade signals, "on-off" pushbuttons or switches, and other speed and temperature controls as required for operation of each item, complete with pilot lights and permanent engraved, plastic laminate signs and graphics identifying each item. Provide stainless steel cover plates at controls and signals.
2. Each item requiring electrical power shall be equipped with either a terminal box for permanent connection or with cord and plug for interruptable connection, as indicated. Provide NEMA standard grounding type plugs, where used.
3. Furnish foodservice equipment completely wired internally using wire and conduit suitable for a wet location, including a separate grounding wire. Provide electrical outlets and receptacles required to be mounted on or in fabricated equipment and interconnect to a suitable terminal box (subpanel, starter, or disconnect switch if so specified) with all wires neatly tagged showing item number, voltage characteristics, and load information.
4. Receptacles for all wall- and floor-mounted outlets will be provided to be used for plug-in equipment with characteristics as noted on the drawings. Provide Hubbell three-wire or four-wire grounding-type connectors and neoprene cords installed on each item of plug-in equipment to match receptacles provided.
5. Electrically heated equipment shall be internally wired to a thermostatic control and an "on-off" red neon light indicator, which shall be mounted in a terminal box on a removable stainless steel access panel.

6. Only rigid steel conduit shall be used, zinc-coated where unexposed and chrome-plated where exposed. Wiring shall be run concealed wherever possible.
7. Provide on or for each motor-driven appliance or electrical heating or control unit, a suitable control switch or starter of the proper type and rating and in accordance with Underwriters Code wherever such equipment is not built in.
8. Appliances shall be furnished complete with motors, driving mechanism, starters, and controllers, including master switches, timers, cut-outs, reversing mechanism, and other electrical equipment if and as applicable. Wiring and connection diagrams shall be furnished with electrically operated machines and for electrically wired fabricated equipment.
9. Appliances shall be of rigid construction, free from objectionable vibration. Quietness of operation of all foodservice equipment is a requirement. Remove or repair any equipment producing objectionable noise and/or vibration as directed by the Contracting Officer.
10. Motors shall be of the drip-proof, splash-proof, or totally enclosed type, having a continuous duty cycle and ball bearings, except small timing motors which may have sleeve bearings. Motors shall have windings impregnated to resist moisture. Motors located where subject to deposits of dust, lint, or other similar matter from the machine on which installed shall be of the totally enclosed type. Motors shall have ample power to operate the machines for which designated under full load operating conditions without exceeding their nameplate ratings. Horsepower requirements on driven equipment shall be determined by the manufacturer based on normal operation at maximum capacity. The nominal rated motor horsepower shall be not less than the horsepower required for normal operation of the equipment at maximum capacity. Insulation shall be NEMA Class B, or better.
11. Cover plates shall be furnished and installed for all electrical outlets, receptacles, switches, etc., to match the material and finish of the equipment to which they will be fastened.
12. Switches, controls, etc., shall be conspicuously labeled as to use with plastic nameplates secured to the adjacent surface as previously specified in Article 2.01-C. Submit a sample for approval if requested by Contracting Officer.
13. Where specified for custom fabricated equipment, provide compartment with electrical sub-panel which shall be pre-wired in conduit concealed in cabinet body construction and connected to all electrical components built into or set upon the counter. Electrical sub-panel shall be UL listed, 3-phase, 4-wire circuit breaker type with a ground buss main breaker and individual breakers for each serviced load. Buss shall be copper and the circuit breakers shall be the molded case, bolt-on type with thermomagnetic quick-make, quick-break trip. Multi-pole circuit breakers shall have an internal trip bar. The circuit breakers shall have an interrupting capacity of 10,000 amperes at 120 volts and there shall be a separate breaker for each connected load. Each breaker shall be sized for 125% of the connected load and a minimum of two (2) extra, single pole, 20 amp circuit breakers shall be provided. The loads shall be connected through the breakers in a phased sequence to balance the load on each phase.

B. Water inlets shall be located above the positive water level wherever possible to prevent siphoning of liquids into the water supply system. Wherever conditions shall require a submerged inlet, a suitable type of check valve (except in jurisdictions where check valves are prohibited) and vacuum breaker shall be provided with the fixture to prevent siphoning. Where exposed, piping and fittings shall be chrome-plated. Where vacuum breaker piping is through equipment, provide chrome-plated escutcheon plates to cover holes.

1. Provide and install indirect waste lines from equipment which will discharge into floor drains or safe wastes, chrome-plated where exposed. Extend to a point at least 25mm (or as required by local or state code) above the rim of the floor drain, cut bottom on 45-degree angle and secure in position.
2. Horizontal piping lines shall be run at the highest possible elevation and not less than 150mm above the floor, through equipment where possible.

3. No exposed piping in or around fixtures or in other conspicuous places shall show tool marks or more than one thread at the fitting.
4. Steam operating valves on or in fabricated and purchased foodservice equipment shall be provided with composition hand wheels, which shall remain reasonably cool in service.
5. Provide suitable pressure-reducing valves for equipment with such components that might reasonably be expected to be affected over a period of time by adverse pressure conditions, including but not limited to dishwashers, booster heaters, coffee urns, steam boilers, etc.

C. Provide and install complete refrigeration systems in a manner that complies with all regulations regarding the reclaim and atmospheric release of refrigerants. Refrigerants used shall be in compliance with the current addition of the Montreal Protocol, and in no case shall refrigerant R-12 be used for new equipment. R-12 may be used to service existing foodservice refrigeration equipment to be reused in accordance with this paragraph and these specifications. All systems shall be charged, started and operating properly and shall include, but not be limited to the following:

1. Compressors, condensers, racks, coils, vibration eliminators, sight glasses (moisture indicating type), expansion valves, filters, oil separators, thermostats, defrost time clocks, all controls and control wiring, liquid line driers, piping, and refrigeration grade copper tubing with all sweat joints using Safety-Silv No. 1200 or approved equal silver solder (with as few joints as possible)

    a. Where specifications call for pre-piped lines (i.e., from a fixture to a valve compartment, etc.), provide such work in strict conformance with other sections of the specifications which set forth standards for this type of work or in conformity with the requirements of the Board of Fire Underwriters or ASHRAE Standards, whichever is the greater.
    b. Mechanically refrigerated cold pans shall have a normally closed liquid line electric solenoid valve installed before the expansion valve and wired to a silent-type toggle switch complete with an "on-off" red neon light indicator and both mounted in a terminal box on a removable access panel. This switch shall be fed by a separate control circuit and shall not to be wired into the compressor circuit so that it shall stop the flow of refrigerant to the cold pan and not turn off the compressor. The compressor shall then pump down and turn off through the action of the pressure control.
    c. Each refrigeration item specification is written to provide minimum specifications and scope of work. Refrigeration equipment shall be designed and installed to maintain the following general temperatures unless otherwise specified.

a. Walk-In Refrigerators	35°F (1.7°C)
b. Walk-In Freezers	-10°F (-23.3°C)
c. Reach-In Refrigerators	35°F (1.7°C)
d. Reach-In Freezers	-10°F (-23.3°C)
e. Undercounter Refrigerators	35°F (1.7°C)
f. Undercounter Freezers	0°F (-17.8°C)
g. Cold Pan	35°F (1.7 °C)
h. Work Rooms	50°F (10°C)

2. Provide electrical and refrigeration components needed by the completed system and complete all connections of and to said components.
3. Provide evaporator coil defrost system on all walk-in refrigerator and freezer rooms where the refrigeration systems are designed to operate at room temperature of less than 35°F (1.7°C).
4. Verify the requirements of and provide any or all additional refrigeration specialty(s) or component(s) required or recommended by the manufacturer for proper operation under the specific operating conditions and location of each system specified.
5. Verify and provide manufacturer's certification (or certification by manufacturer's authorized agent) that the equipment selection hereinafter specified for each refrigeration system is properly sized and shall meet the operating requirements set forth for each system regarding maintaining specified operating temperature, hours of compressor running time, and system pressures and velocities as recommended by the equipment manufacturer(s).

6. During check-out and initial operation, make sure that:

    a. Controls are properly adjusted, including refrigeration circuits, room air temperature controls, etc.
    b. Condensers will carry an overload protector.
    c. A competent service mechanic is available during the first eight (8) hours of operation.
    d. Switches, starters, and controls are identified as to function.

7. Unless otherwise specified, thermometers for walk-in units will be furnished with suitable length armored capillary tubes to allow the sensing bulb to be installed in the incoming air stream to the blower coil with runs fastened to the walk-in walls to prevent it from damage. This identical requirement applies to alarm systems when specified.

2.5 PRODUCT SPECIFICATIONS

A. Refer to Part 4 for complete itemized product specifications.

2.6 MISCELLANEOUS MATERIALS

A. Installation Accessories, General: NSF certified for end-use application indicated.

B. Elastomeric Joint Sealant: ASTM C 920; Type S (single component), Grade NS (nonsag), Class 25, Use NT (nontraffic) related to exposure, and Use M, G, A, or O as applicable to joint substrates indicated.

1. Public Health and Safety Requirements:

    a. Sealant is certified for compliance with NSF standards for end-use application indicated.
    b. Washed and cured sealant complies with the FDA's regulations for use in areas that come in contact with food.

2. Cylindrical Sealant Backing: ASTM C 1330, Type C, closed-cell polyethylene, in diameter larger than joint width.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install foodservice equipment level and plumb, according to manufacturer's written instructions.

1. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

B. Complete equipment assembly where field assembly is required.

1. Provide closed butt and contact joints that do not require a filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish.

C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and requirements of authorities having jurisdiction. Verify equipment access and maintenance-clearance requirements of authorities having jurisdiction and of local sanitation and health codes; reflect minimum clearances on Drawings.

D. Install cabinets and similar equipment on concrete and masonry bases in a bed of sealant.

E. Install closure-trim strips and similar items requiring fasteners in a bed of sealant.

F. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

3.2 CLEANING AND PROTECTING

A. After completing installation of equipment, repair damaged finishes.

B. Clean and adjust equipment as required to produce ready-for-use condition.

C. Protect equipment from damage during remainder of the construction period.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain foodservice equipment. Refer to Division 1 Section: Closeout Procedures; Demonstration and Training.

3.4 ITEMIZED PRODUCT SPECIFICATIONS

A. Each model number includes the code *F086 as a suffix. This code is known as the Specifier Identification System (SIS). It is not to be removed by the bidders. Its purpose is to identify the specifier to the vendors providing equipment in the event it is necessary to communicate questions, clarifications and comments, from prior to bid award through the final purchase. It is to be used on all correspondence including fax and e-mail when communicating with manufacturer representatives and factories.

Sample: Item 102, Description
Manufacturer Name, Model Number
Quantity:

Item 01 Hand Sink Wall Mount

Eagle HAS-10-FAW

Qty: 4

- Provide unit complete with gooseneck faucet with wrist blade handles, aerator and drain
- Provide (1) unit, located in banquet pantry, with right side stainless steel splash guard

Item 02 POS Terminal

NIKEC – By Owner

Qty: 1

- This item is not included in the kitchen equipment contract

Item 03 Beverage Counter

Custom Fabricated

Qty: 1

- 18'0" long x 2'6" wide x 3'0" high stainless steel back counter constructed and equipped in accordance with the Plan, Elevation 1 and Detail 4.01
- Inverted "V" edge per Detail 1.02C
- 6" high back splash per Detail 1.04
- Glass rack slides in section below Coffee Brewer, Item 07
- Cut out to accommodate vendor supplied Soda/Ice Dispenser, Item 08 – KEC to verify size with Owner
- Removable access panel below Drop In Soda/Ice Dispenser, Item 08
- Recess to accommodate Undercounter Refrigerator, Item 110
- Hinged access door below Sink, Item 14, per Detail 4.26
- Balance of counter to have open shelving with adjustable intermediate shelf
- 1-1/2" high turn up on right end

Item 04 Wall Cabinet

Glastender WCO36

Qty: 2

- Mount bottom shelf at 54" AFF

Item 05 Coffee Grinder

Bunn 35600.0020 MHG SST

Qty: 2

- Unit to be compatible with Coffee Brewer, Item 07

Item 06 Water Filter, Beverage Combo

3M DF290-CL

Qty: 1

- Unit to accommodate flow rates of Coffee Brewer, Item 7, Iced Tea Brewer, Item 9, and Espresso Machine, Item 11
- Mount at 78" AFF

Item 07 Coffee Brewer

Bunn 34600.0004 Dual TF DBC SST

Qty: 1

- 120/208/60/1 electrical configuration
- Stainless steel finish
- Stainless steel brew baskets
- Hot water spigot
- Provide each unit with (3) 42750.000 TF Server DSG2 1.5G SST dispensers with integral stand – (2) with black handles and (1) with orange handle – KEC to verify size, finish and style with Owner prior to procurement

Item 08 Soda/Ice Dispenser, Drop In

NIKEC – By Vendor

Qty: 2

- This item is not included in the kitchen equipment contract

Item 09 Iced Tea Brewer

NIKEC – By Vendor

Qty: 2

- This item is not included in the kitchen equipment contract

Item 10 Undercounter Refrigerator

Hoshizaki UR48A

Qty: 2

- 2.25" Low profile casters to fit in recess below counter per Plan

Item 11 Espresso Machine, Automatic

Nuova Simonelli ProntoBar

Qty: 1

- Dual grinder
- Stainless steel steam wand
- Black finish

- Hard plumbed, interconnect to Water Filter, Item 06
- 208/60/1 electrical configuration with cord and plug set

Item 12 Open Number

Item 13 Wall Shelf

Glastender WCO42

Qty: 2

- Mount bottom shelf at 54" AFF

Item 14 Sink, Welded

Eagle FDI-16-19-13.5-1

Qty: 1

- Fully weld to Beverage Counter, Item 03, as show on Plan
- T&S B-0225-61X-CCCR 4" deck mounted body with 10" swing faucet, lever handles and aerator
- Basket style drain

Item 15 Slicer

Globe S13A

Qty: 1

- Vegetable hopper

Item 16 Mixer, 40Qt, Floor

Globe SP40

Qty: 1

- Standard accessory package
- XXACC20-40 adapter kit with 20qt bowl and standard accessories
- XVSGH slicer/shredder/grater housing
- SASP adjustable slicing plate
- SPH pate holder
- XSP14 ¼" shredding plate
- XGP grating plate
- KEC to verify plate size requirements with Owner prior to procurement

Item 17 Work Table, Mobile

Eagle T2448SE Modififed

Qty: 1

- 3'6" long x 2'0" wide stainless steel table with flat top and undershelf
- Casters, two with brakes

Item 18 Reach In Refrigerator

Hoshizaki R2A-HS

Qty: 1

- Casters, front with brakes
- One additional shelf in each side

Item 19 Undercounter Refrigerator

Hoshizaki UR60A-D4

Qty: 1

- 2.25" casters to fit in recess below Work Table, Item 20, per Plan
- Drawers for all sections

Item 20 Work Table

Eagle T30144STE-BS Modified

Qty: 1

- 13'4" long x 2'6" wide x 3'0" high stainless steel work table with back splash and open base
- Right side splash
- Two compartment sink, fully welded, specified as Item 22
- Recess without rear cross bracing to accommodate Undercounter Refrigerator, Item 19, with stabilizer bar as required
- Mitered right side front edge as required not to conflict with doorway – KEC to field verify

Item 21 Wall Shelf

Eagle WS12144 Modified

Qty: 1

- 13'4" long x 1'0" wide stainless steel wall shelf
- Right side turn up
- Mount at 68" AFF not to conflict with Slicer, Item 15

Item 21A Wall Shelf

Eagle WS1296

Qty: 1

- 8'0" long x 1'0" wide stainless steel wall shelf
- Right side turn up
- Mount at 54" AFF

Item 22 Two Compartment Sink, Welded

Eagle FDI-22-22-13.5-2

Qty: 1

- Fully weld to Work Table, Item 20, as shown on Plan
- T&S B-0231 splash mounted 12" swing faucet with lever handles and aerator
- (2) lever operated drains with support bracket and overflows

Item 23 Work Table, Maple Top

John Boos HNS10

Qty: 1

- 5'0" long x 2'6" wide x 3'0" high work table with 1-3/4" thick maple flat top
- Stainless steel base, legs, gussets, and undershelf
- Casters, all with brakes

Item 24 Open Number

Item 25 Ice Bin

Follet SG1000S-36

Qty: 1

- Mounting kit as required to accept Ice Cuber, Item 26
- Ice paddle and hanging bracket

Item 26 Ice Cuber, Remote Air Cooled

Hoshizaki KM-1100MRJ

Qty: 1

- Self contained, remote unit mounted on Ice Bin, Item 25
- Interconnect to Water Filter, Item 32
- Interconnect to Remote Condenser, Item 26A

Item 26A Remote Condenser, Ice Cuber, Air Cooled

Hoshizaki URC-14F

Qty: 1

- Interconnect to Ice Cuber, Item 26
- KEC to verify exact location and line run
- Pre-charged line set – verify length requirement
- Outdoor, weather proof enclosure with legs

Item 27 Floor Trough

Eagle ASFT-1236-SG

Qty: 1

- Stainless steel subway grating
- Removable perforated scrap basket

Item 28 Floor Trough

Eagle ASFT-1224-SG

Qty: 1

- Stainless steel subway grating
- Removable perforated scrap basket

Item 29 Ice Bin

Hoshizaki B-300SF

Qty: 1

- Mounting kit as required to accept Ice Flaker, Item 30

Item 30 Ice Flaker, Remote Air Cooled

Hoshizaki F-1002MRJ

Qty: 1

- Self contained, remote unit mounted on Ice Bin, Item 29
- Interconnect to Water Filter, Item 31
- Interconnect to Remote Condenser, Item 30A

Item 30A Remote Condenser, Ice Flaker, Air Cooled

Hoshizaki URC-5F

Qty: 1

- Interconnect to Ice Cuber, Item 30

- KEC to verify exact location and line run
- Pre-charged line set – verify length requirement
- Outdoor, weather proof enclosure with legs

Item 31 Water Filter, Ice Flaker

3M ICE160-S

Qty: 1

- Unit sized to accommodate flow rate of Ice Flaker, Item 30
- Mount at 78" AFF

Item 32 Water Filter, Ice Cuber

3M ICE190-S

Qty: 1

- Unit sized to accommodate flow rate of Ice Cuber, Item 26
- Mount at 78" AFF

Item 33 Mop Sink Cabinet

Eagle F1916-VSCS

Qty: 1

- Hose and hose bracket
- Service faucet specified as Item 34

Item 34 Service Faucet

T&S B-0655-BSTP

Qty: 1

- Mount at 36" AFF

Item 35 Open Number

Item 36 Open Number

Item 37 Hot Holding Cabinet, Mobile

Cres Cor 1000-HH-SS-2D

Qty: 4

- Corner bumpers

Item 38 Work Table

Eagle T2436SE Modified Height

Qty: 1

- 3'0" long x 2'0" wide x 34" high stainless steel work table with flat top and undershelf
- Casters, front with brakes

Item 39 Batch Freezer

Stoelting VB9

Qty: 1

- Self contained, air cooled unit
- Cord and plug set

Item 40 Fire Protection System

Ansul R-102

Qty 1

- System shall provide surface, plenum and duct protection for the items of cooking equipment located beneath the Ventilator, Item 41, in accordance with all applicable codes, ordinances, regulations, and the provisions of NFPA 17A and 96 and UL300 and per Accurex Drawings, dated 09/30/2019, refer to Sheets K1.8-K1.10
- All system piping fittings and conduit shall be concealed where possible and, if exposed, shall be stainless or chrome-plated finish with no exposed threads
- System to be interwired with shunt-trip breaker serving items of cooking equipment beneath the ventilator to provide for power shut-off in the event of system actuation in accordance with Details 6.21 and 6.22
- Recessed remote fire pull station located per Mechanical Plan between 4'6" (1350mm) and 5'0" (1500mm) above finished floor
- Location of fire pull to be verified with local/state codes. (BOCA 93: pull to be minimum of 10'3" (3,000mm) away from hood)
- Manufacturer to comply with all state and local codes
- Installation, field inspection, and certification to be performed by factory authorized Ansul agency
- Mount system in utility cabinets of Exhaust Hood, Item 41

Item 41 Exhaust Hood

Accurex XXDW-90-S

Qty 1

- Unit to consist of four (4) 54" wide x 90" long x 24" high hood sections for a ceiling mount, island style orientation as shown on Plan (as Items 41A-D) with an additional 14" wide front and side supply plenum
- Refer to sheets K1.8-K1.10 Ventilator Details and Schedule for exhaust and supply air data, sections and details
- Two (2) round LED light fixtures per section with shatter proof covers wired to junction box
- Utility cabinet with fire protection system factory installed and pre-piped
- Unit to be interconnected with Fire Protection System, Item 40

- Piping for Fire Protection System, Item 40, to be provided internally in ventilator by ventilator manufacturer
- 18-gauge stainless steel removable enclosure panels from top of ventilator to underside of building ceiling
- KES ecoAzur Plus Hood controls, complete system with all components, cloud package, startup and programming – VFD's by mechanical trade - KEC to coordinate with mechanical engineer
- Factory mounted exhaust collars
- Manufacturer to comply with all state and local codes
- Manufacturer to supervise unit installation

Item 42 Floor Trough

Eagle ASFT-2424-SG

Qty: 1

- Stainless steel subway grating
- Removable perforated scrap basket
- Unit to accept full pour path of Kettle, Item 42

Item 43 Kettle, 40 Gal, Electric

Southbend KELT-40

Qty: 1

- Electric operated, 480/60/3 configuration
- Manual tilting
- 2" tangent draw off valve with perforated strainer TVT-2-TPS
- Spring assist hinged cover
- Etched gallon markings
- Double pantry faucet with swing spout and mounting assembly
- Center unit over Floor Trough, Item 42

Item 44 Hot Top Range, Electric

Southbend SE36D-HHH

Qty: 1

- Electric operated, 480/60/3 configuration
- Three section hot top with standard oven base
- Casters, front with brakes
- Stainless steel rear enclosure panel
- (1) additional oven rack

Item 45 Combi Oven, Double, Electric

Rational Self Cooking Center 62/62E

Qty: 1

- Electric operated, 480/60/3 configuration
- Casters, front with brakes
- Factory menu programming and start up
- Standard probe
- Interconnect to Water Filter, Item 46, mounted on back of units
- Left side heat shield for controls

Item 46 Water Filter, Combi

3M SF165

Qty: 1

- Unit sized to accommodate flow rate of double stacked Combi Oven, Item 45, and Pasta Cooker, Item 47
- Mount to rear panel of Combi Oven, Item 45 – Verify with manufacturer

Item 47 Pasta Cooker, Electric

Electrolux 391204

Qty: 1

- Electric operated, 208/60/3 configuration
- Double well unit
- Casters, two swivel with brakes
- Auto water fill – interconnect to Water Filter, Item 46
- Tank covers
- Stainless steel back panel
- Stainless steel side panels
- One pair of baskets for 10.5 gallon cooker
- Basket support bracket for both tanks
- One set of six single portion baskets for 10.5 gallon cooker, with support rack
- KEC to verify basket requirements with Owner prior to procurement

Item 48 Range, Electric

Southbend SE36A-BBB

Qty: 1

- Electric operated, 480/60/3 configuration
- Six round hot plate top with convection oven base

- Casters, front with brakes
- One additional oven rack
- Stainless steel rear panel
- Flue riser mounting assembly to accommodate Salamander, Item 49

Item 49 Salamander Broiler, Electric

Vulcan 36ESB-480

Qty: 1

- Electric operated, 480/60/3 configuration
- Range mount to Range, Item 48
- Stainless steel bottom panel
- Stainless steel back panel

Item 50 Fryer, Electric

Pitco SE148R

Qty: 2

- Electric operated, 480/60/3 configuration
- Cord and plug set
- Two twin baskets for each fryer
- Tank covers
- Casters, front with brakes

Item 51 Griddle, Electric

Star 736TA

Qty: 1

- Electric operated, 208/60/3 configuration
- Thermostatic controls

Item 52 Refrigerated Equipment Stand

Hoshizaki CR72A

Qty: 1

- Electric operated, 480/60/3 configuration

Item 53 Chargrill, Electric

Star 5136CF

Qty: 1

- Electric operated, 208/60/3 configuration

Item 54 POS Remote Printer

NIKEC – By Owner

Qty: 3

- This item is not included in the kitchen equipment contract

Item 55 Hand Sink, Welded

Eagle FDI-16-19-8-1

Qty: 1

- Fully weld to Counter Item 64, as shown on Plan
- Faucet specified as Item 55A
- Basket style drain
- Integral soap and paper towel dispensers mounted to counter

Item 55A Faucet, Deck Mount

T&S B-0325

Qty: 1

- Deck mounted swivel gooseneck faucet with wrist blade handles and aerator

Item 56 Sandwich Prep Table

Hoshizaki CRMR60-24MD2

Qty: 1

- Stainless steel rear panel
- Double overshelf assembly, pass through style, to align with adjacent Overshelf, Item 59
- Drawers on left side, door on right side

Item 57 Utility Sink, Welded

Eagle FDI-16-19-13.5-1

Qty: 1

- Fully weld to Counter Item 64, as shown on Plan
- T&S B-0325 deck mounted swivel gooseneck faucet with lever handles and aerator

- Lever operated drain with support bracket
- Stainless steel sink cover

Item 58 Heat Lamp

Vollrath 72721-32

Qty: 2

- High output, double wide unit with lights
- Mount below top tier of Double Overshelf, Item 59
- Remote infinite controls mounted to front face of Counter, Item 64, on cook's side
- 120/208/60/1 electrical configuration

Item 59 Double Overshelf

Eagle OS18108

Qty: 1

- 9'0" long x 1'6" wide double overshelf assembly mounted to Counter, Item 64, per Plan and Elevation 2
- Extend uprights and weld to counter framework
- First shelf to be 18" above counter height, second shelf to be 15" above first shelf
- Provisions to accept Heat Lamps, Item 58, below top tier – conceal all wiring in uprights

Item 60 Undercounter Refrigerator

Hoshizaki CRMR48-D4

Qty: 2

- 2.25" low profile casters to fit below Counter, Item 64, per Plan and Elevations 2 and 3

Item 61 Heat Lamp, Decorative

Hatco DLH-RT-775-L

Qty: 4

- High watt units
- Retractable cord mount to track adapter – KEC to verify track and cord colors with Architect
- Lower switch
- Standard finish – KEC to verify finish with Architect
- Coated clear bulbs
- KEC to field verify ceiling height

Item 62 Heat Lamp

Vollrath 72724-32

Qty: 1

- High output, double wide unit with lights
- Mount below top tier of Double Overshelf, Item 63
- Remote infinite controls mounted to front face of Counter, Item 64, on cook's side
- 120/208/60/1 electrical configuration

Item 63 Double Overshelf

Eagle OS1884

Qty: 1

- 7'0" long x 1'6" wide double overshelf assembly mounted to Counter, Item 64, per Plan and Elevation 3
- Extend uprights and weld to counter framework
- First shelf to be 18" above counter height, second shelf to be 15" above first shelf
- Provisions to accept Heat Lamp, Item 62, below top tier – conceal all wiring in uprights

Item 64 Chef's Counter, "L" Shape

Eagle Custom Fabricated

Qty: 1

- "L" shaped counter with two 12'0" long x 3'0" wide x 3'0" high sections constructed and equipped in accordance with the Plan, Detail 4.02, and Elevations 2 and 3
- Two double Overshelf Assemblies, Items 59 and 63, located per Plan - Extend uprights and weld to counter framework
- Two fully welded sinks specified as Items 55 and 57 – provide hole in base of counter below sinks for drain lines
- Recess to accommodate two Undercounter Refrigerators, Item 60
- Stainless steel apron to accept controls for Heat Lamps, Items 58 and 62
- Finished stainless steel back panel with toe kick
- Open shelving with adjustable intermediate shelf in balance of counter (exception for areas below sinks)
- Open shelving with intermediate shelf at corner accessible on expeditor's side

Item 65 Sandwich Prep Table

Hoshizaki CRMR48-18MD2

Qty: 1

- Stainless steel rear panel
- Double overshelf assembly, pass through style, to align with adjacent Overshelf, Item 63
- Drawers on left side, door on right side

Item 66 Open Number

Item 67 Hand Sink, Wall Mount

Advance 7-PS-25

Qty: 1

- Provide unit complete with faucet with wrist blade handles and drain
- Left and right side welded stainless steel splash guards

Item 68 Shelf Unit

Metro Super Erecta MetroSeal3 Wire Series

Qty: 11

- Shelf unit to consist of four (4) MetroSeal3 coated Super Erecta storage shelves complete with split sleeves and posts
- (3) 1436NK3 - 14” wide x 36” long shelf units
- (1) 1836NK3 - 18” wide x 36” long shelf unit
- (1) 1848NK3 - 18” wide x 48” long shelf unit
- (2) 2448NK3 - 24” wide x 48” long shelf units
- (3) 2454NK3 - 24” wide x 54” long shelf units
- (1) 3048NK3 - 30” wide x 48” long shelf unit
- Unit to have four (4) 74UPK3 posts with casters, two with brakes
- Install first tier at 10” AFF and space others equally
- KEC to field verify size and height requirements prior to installation

Item 69 Three Compartment Sink

Eagle 314-22-3-24

Qty: 1

- Stainless steel legs, gussets and adjustable bullet feet
- Left side splash
- Faucets specified as Item 70, punch splash for two faucets as shown on Plan
- (3) lever operated drains with support brackets and overflows

Item 70 Faucet, Splash Mount

T&S B-0231-CC

Qty: 2

- Splash mounted 12” swing faucet with lever handles and aerator
- Mount on Three Compartment Sink, Item 69

Item 71 Wall Shelf

Eagle WS12120

Qty: 1

- 10'0" long x 1'0" wide stainless steel wall shelf
- 1-1/2 high turn up left end
- Mount at 54" AFF per Plan and Elevation 4

Item 71A Wall Shelf

Eagle WS12144 Modified

Qty: 1

- 11'9" long x 1'3" wide stainless steel wall shelf
- 1-1/2 high turn up left end
- Mount at 68" AFF per Plan and Elevation 4

Item 71B Wall Shelf

Eagle WS18120, WS1896 Modified

Qty: 1

- (1)10'0" long x 1'6" wide stainless steel wall shelf with 1-1/2" high turn up on left end
- (1) 7'4" long x 1'6" wide stainless steel wall shelf with 1-1/2" high turn up on right end
- Field weld seam between shelves
- KEC to field verify dimensions for wall to wall installation, provide stainless steel trim strips if required to seal to walls on both ends
- Mount at 84" AFF per Plan and Elevation 4

Item 72 Dish Rack Shelf

Eagle 606643

Qty: 1

- Mount at 54" AFF

Item 73 Clean Dish Table "L" Shape

Eagle CDTCL-60-14/3 Modified

Qty: 1

- One 5'2" long machine table leg x one 5'9" long leg "L" shaped clean dish table as shown on Plan – KEC to field verify dimensions
- Connect to Dishmachine, Item 74
- Mount table limit switch
- Stainless steel legs, gussets and adjustable bullet feet

Item 74 Conveyor Dishmachine, High Temp

Champion 70 DRFFPW

Qty: 1

- 44" DR series high temperature conveyor dish machine with 26" front feed pre-wash section right side as shown on Plan
- Right to left orientation
- Electric tank heat
- Heat recovery system
- Internal 12KW booster heater for 40 degree rise – KEC to verify 140 degree incoming hot water for 180 degree final rinse
- 480/60/3 electrical configuration
- Vent cowls with locking dampers
- (2) Stainless steel vent ducts by KEC
- Stainless steel wall flashing by KEC from coved based to underside of ceiling for area behind dish machine and wing wall of corner pre-rinse section as shown on Sheet K1.6, Note T
- Table limit switch mounted to Clean Dishtable, Item 73
- Drain tempering kit

Item 75 Pre-Rinse Faucet

T&S B-0133-B

Qty: 1

- Low flow spray gun – KEC to verify GPM requirements prior to procurement
- B-0109 wall mounting bracket
- Mount to pre-rinse sink of Soiled Dishtable, Item 77

Item 76 Waste Disposer

Salvajor 200-CA-6 ARSS-2 (208/60/3)

Qty: 1

- Mount in pre-rinse sink of Soiled Dishtable, Item 77, as shown on Plan
- Control bracket
- Support leg
- Rubber stopper

Item 77 Soiled Dishtable "L" Shape

Eagle SDTLR-72-14/3

Qty: 1

- 6'0" long landing shelf section – size and shape per Plan
- Provisions to accept Waste Disposer, Item 76, including control bracket, punch splash for vacuum breaker
- Stainless steel legs, gussets and adjustable bullet feet

- Removable scrap basket
- Double sided sorting shelf specified as Item 78
- Verify requirements to connect to Dish Machine, Item 74

Item 78 Dish Rack Shelf, Double Sided

Eagle 606295

Qty: 1

- 6'0" long double sided tubular style assembly mounted to landing shelf of Soiled Dishtable, Item 77, as shown on Plan
- Extend uprights and weld to counter framework
- Wall mounting bracket right side – KEC to coordinate blocking in wall with GC

Item 79 Open Number

Item 80 Open Number

Item 81 Banquet Cart

Cres Cor CCB-120A

Qty: 1

- (2) kold keepers

Item 82/82A Walk In Refrigeration Complex

ThermalRite

Qty 1

- One 20'10" long leg x one 19'2" long leg x 16'4" wide x 8'6" high complex, size and shape per Plan and per ThermalRite quote number 292457, dated 12/06/2019
- Complex to consist of two compartments: One 19'2" long x 16'4" wide x 11'7" refrigerated compartment and one 9'3" long x 7'9" wide freezer compartment separated by an internal 4" wide partition wall with standard entrance door – KEC to field verify all dimensions
- Two standard 36" x 78" self-closing walk in doors hinged and located per Plan with third hinge, 36" aluminum tread plate on both sides, and heated viewport window and mortise lock
- Pressure relief valve for Freezer compartment
- Embossed aluminum exposed exterior and interior
- Galvalume concealed exterior
- White painted smooth aluminum interior ceiling
- Pre-fabricated insulated floor panels with interior ramp
- NSF construction
- Matching finish trim strips to adjacent walls and removable enclosure panels to ceiling

- Audio visual alarm
- Five (5) 4'0" long LED light fixtures in addition to standard light at doors

Item 83 Evaporator Coil, Ref

ThermalRite LCA6160AEQRC6B

Qty 1

- Center mount evaporator furnished per ThermalRite quote number 292457, dated 12/06/2019
- KEC to verify size for a fully operational refrigeration system sized to accommodate refrigerated compartment of Walk In Complex, Item 82
- Evaporator coil to be hung from non-corrosive, non-conductive rods
- KEC to verify location of remote outdoor condenser, Item 84, and interconnect with Evaporator Coil
- Approximate line run to be verified by KEC
- System shall be installed complete with all necessary components and accessories as described in Electrical and Mechanical Requirement Sections of General Conditions of Foodservice Equipment Specifications
- Size system to operate at 35°F

Item 84 Remote Condensing Unit, Ref.

ThermalRite MOH025X62CFM

Qty 1

- Air-cooled, outdoor, remote, 2.5 HP, medium temp, hermetic system per ThermalRite quote number 292457, dated 12/06/2019
- Pre-engineered and factory assembled unit
- System to be an outdoor system housed in a single, compact, rust-proof cabinet
- KEC to verify location of remote outdoor unit and interconnect with Evaporator Coil, Item 83
- Approximate line run to be verified by KEC
- System shall be installed complete with all necessary components and accessories as described in Electrical and Mechanical Requirement Section of General Conditions of Foodservice Equipment Specifications
- Size system to operate at 35°F

Item 85 Evaporator Coil, Freezer

ThermalRite LCE694BEQRC6BFF

Qty 1

- Center mount evaporator furnished per ThermalRite quote number 292457, dated 12/06/2019
- KEC to verify size for a fully operational refrigeration system sized to accommodate freezer compartment of Walk In Complex, Item 82A
- Evaporator coil to be hung from non-corrosive, non-conductive rods
- KEC to verify location of remote outdoor condenser, Item 86, and interconnect with Evaporator Coil and time clock
- Approximate line run to be verified by KEC

- Wrap drain line in heater tape
- System shall be installed complete with all necessary components and accessories as described in Electrical and Mechanical Requirement Sections of General Conditions of Foodservice Equipment Specifications
- Size system to operate at -10°F

Item 86 Condensing Unit, Freezer

ThermalRite MOH025L62CFLT

Qty 1

- Air-cooled, outdoor, remote, 2.5 HP, low temp, hermetic system per ThermalRite quote number 292457, dated 12/06/2019
- Pre-engineered and factory assembled unit
- System to be an outdoor system housed in a single, compact, rust-proof cabinet
- KEC to verify location of remote outdoor Refrigeration System and interconnect with Evaporator Coil, Item 85 and time clock
- Approximate line run to be verified by KEC
- System shall be installed complete with all necessary components and accessories as described in Electrical and Mechanical Requirement Section of General Conditions of Foodservice Equipment Specifications
- Size system to operate at -10ºF

Item 87 Shelf Unit

Metro Super Erecta MetroSeal3 Wire Series

Qty: 14

- Shelf unit to consist of four (4) MetroSeal3 coated Super Erecta storage shelves complete with split sleeves and posts
- (1) 1836NK3 - 18” wide x 36” long shelf unit
- (4) 2442NK3 - 24” wide x 42” long shelf units
- (6) 2448NK3 - 24” wide x 48” long shelf units
- (1) 2454NK3 - 24” wide x 54” long shelf unit
- (1) 2472NK3 - 24” wide x 72” long shelf unit
- Unit to have four (4) 74PK3 stationary posts with adjustable metal bullet feet
- Install first tier at 10” AFF and space others equally
- KEC to field verify size and height requirements prior to installation

Item 88 Pan Rack

Cres Cor 207-1820

Qty: 3

- Heavy duty casters, front two with brakes
- Welded pan stop
- Vertical bumpers
- Vinyl covers

Item 89 Shelf Unit

Metro Super Erecta Wire Series

Qty: 10

- Shelf unit to consist of five (5) Brite Wire Super Erecta storage shelves complete with split sleeves and posts
- (6) 2442BR - 24" wide x 42" long shelf units
- (3) 2448BR - 24" wide x 48" long shelf units
- (1) 2454NC - 24" wide x 54" long shelf unit
- Unit to have four (4) 86P stationary posts with adjustable metal bullet feet
- Install first tier at 10" AFF and space others equally
- KEC to field verify size and height requirements prior to installation

Item 90 Beer Keg Rack

Channel KAR80

Qty: 1

- KS180 movable back stop

Item 90A Beer Keg Rack

Channel KAR60

Qty: 1

- KS160 movable back stop

Item 90B Beer Keg Dunnage Rack

Channel KDR136

Qty: 1

Item 91 Beer Power Pack System

MicroMatic MMPP4302

Qty: 1

- System sized to accommodate 4 flavors of beer from Keg Cooler to Beer Tower, Item 113
- Unit to be located on top of walk in box as shown on Plan
- KEC to provide all components for a fully operational draft system
- KEC to verify line run

Item 92 Water Filter, Coffee

3M Brew 130

Qty: 1

- System sized to accommodate flow rates of Coffee Brewer, Item 07, and Ice Tea Brewer, Item 09
- Wall mount at 78" AFF

Item 93 Water Filter, Drinking Water

3M DWS160-L

Qty: 1

- System sized to accommodate flow rate Glass Filler Faucet, Item 94
- Wall mount at 24" AFF

Item 94 Glass Fill Faucet and Drainer

T&S B-1230-12

Qty: 1

- Deck mount station with pedestal glass filler and built in stainless steel drip pan plumbed to floor sink
- Install in Beverage Counter, Item 96, per Plan
- Interconnect to Water Filter, Item 93

Item 95 Sink, Welded

Eagle FDI-16-19-13.5-1

Qty: 1

- Unit to be fully welded to Beverage Counter, Item 96, as shown on Plan
- T&S B-0325 deck mounted swivel gooseneck faucet with lever handles and aerator
- Basket style drain

Item 96 Beverage Counter

Custom Fabricated

Qty: 1

- 14'0" long x 2'6" wide x 3'0" high stainless steel back counter constructed and equipped in accordance with the Plan, Elevation 5, and Detail 4.01
- 6" high back splash per Detail 1.04
- Inverted "V" edge per Detail 1.02C
- Recess for Undercounter Refrigerator, Item 10
- Removable access panel below Drop In Soda Dispenser, Item 08
- Hinged louvered door per Detail 4.26 below Sink, Item 95
- Open shelving with adjustable intermediate shelf in balance of counter

Item 97 Wall Cabinet

Glastender WCO60

Qty: 1

- Mount bottom shelf at 54" AFF

Item 98 Ice Bin

Hoshizaki B-800SF

Qty: 1

- Mounting kit as required to accept Ice Bin, Item 99

Item 99 Ice Cuber

Hoshizaki KM-1100MRH

Qty: 1

- Remote air cooled unit
- Mount on Ice Bin, Item 98
- Interconnect to Water Filter, Item 100
- Interconnect to Remote Condenser, Item 99A

Item 99A Remote Condenser, Ice Cuber, Air Cooled

Hoshizaki URC-14F

Qty: 1

- Interconnect to Ice Cuber, Item 99
- KEC to verify exact location and line run
- Pre-charged line set – verify length requirement
- Outdoor, weather proof enclosure with legs (or stacking kit to mount on Condenser, Item 26A – verify requirements prior to procurement)

Item 100 Water Filter, Ice

3M ICE190

Qty: 1

- Size system to accommodate Ice Cuber, Item 99
- Mount at 78" AFF

Item 101 Work Table

Eagle T3696STE

Qty: 1

- 8'0" long x 3'0" wide x 3'0" high stainless steel flat top work table with open base
- Casters, all with brakes

Item 102 Work Table

Eagle T3648SE

Qty: 1

- 4'0" long x 3'0" wide x 3'0" high stainless steel flat top work table with undershelf
- Casters, all with brakes
- Single overshelf specified as Item 103

Item 103 Single Overshelf

Eagle OS1548

Qty: 1

- 4'0" long x 1'3" wide single overshelf mounted to Work Table, Item 102 – extend uprights and weld to table framework
- Center mount

Item 104 Underbar Glassrack Cabinet

Glastender DBGR-24

Qty: 2

- Drainboard top, storage below for two standard size glass racks
- Locate unit per Plan and join to adjacent underbar equipment

Item 105 Underbar Combo Ice Bin

Glastender CBA-36R-ED-CP10

Qty: 2

- "A" depth extra deep ice bin
- Common speed rail with adjacent items, specified as Item 106
- Cold plate
- Juice wells on right side
- Clip on condiment bin
- Soda chase in back splash
- Locate unit per Plan and join to adjacent underbar equipment

Item 106 Speed Rail

Glastender SSR-48

Qty: 2

- Mount to Ice Bin, Item 105, and Sink, Item 107
- SSRC-48 locking night cover
- Locate unit per Plan and join to adjacent underbar equipment

Item 107 Underbar Sink

Glastender SWA-12

Qty: 2

- Provide unit complete with faucet and drain
- Removable perforated sink strainer
- Locate unit per Plan and join to adjacent underbar equipment

Item 108 Underbar Trash Module

Glastender DWB-12

Qty: 1

- Locate unit per Plan and join to adjacent underbar equipment

Item 109 Undercounter Dishmachine

Champion UH330B

Qty: 1

- High temperature unit with built in booster heater
- 208/60/1 electrical configuration
- Drain tempering kit

Item 110 Underbar Hand Sink

Glastender DHSB-12

Qty: 2

- Provide unit complete with faucet and drain
- Integral soap and paper towel dispenser
- Locate unit per Plan and join to adjacent underbar equipment

Item 111 Mug Froster

Glastender MF24-S2

Qty: 1

- Stainless steel construction
- Two layers of shelving
- Interior light
- Auto defrost

Item 112 Back Bar Refrigerator

Glastender BB84L-XN(LRR)

Qty: 1

- Condenser compartment left side
- Stainless steel glass doors – KEC to verify finishes with Owner
- Provide less finished top for installation below millwork counter – KEC to coordinate recess with GC and Millwork Fabricator
- Door locks

Item 113 Beer Tower

MicroMatic Metro-T-4PVDKR

Qty: 1

- Four flavor unit
- PVD Brass finish – KEC to verify finish with Architect prior to procurement
- Faucet locks
- Mount on front bar – KEC to coordinate installation requirements with GC and Millwork Fabricator
- Interconnect to Beer System, Item 91

Item 113A Drain Pan

MicroMatic DP-120DSSPVD-24

Qty: 1

- 24” long unit sized to accommodate full pour path of Beer Tower, Item 113
- PVD Brass finish to match beer tower – KEC to verify finishes with Architect

Item 114 Back Bar Refrigerator

Glastender BB84R-XN(LLR)

Qty: 1

- Condenser compartment right side
- Stainless steel glass doors – KEC to verify finishes with Owner

- Provide less finished top for installation below millwork counter – KEC to coordinate recess with GC and Millwork Fabricator
- Door locks

Item 115 Trash Can, Slim Jim

Rubbermaid 3450

Qty: 1

- Black

Item 116 Open Number

Item 117 Open Number

Item 118 Open Number

Item 119 Open Number

Item 120/120A Underbar Ice Bin with Juice Insert

Glastender IBB-12

Qty: 1

- "B" depth standard deep
- BW4 juice well insert positioned right
- Locate unit per Plan and join to adjacent underbar equipment

Item 121 Underbar Drainboard Cabinet

Glastender DBCB-12LD

Qty: 1

- Provide unit less door with adjustable intermediate shelf
- Locate unit per Plan and join to adjacent underbar equipment

Item 122 Underbar Blender Station

Glastender BSA-12

Qty: 1

- Provide unit complete with faucet and drain
- Duplex receptacle installed below blender shelf for Blender, Item 123
- Locate unit per Plan and join to adjacent underbar equipment

Item 123 Bar Blender

Waring BB150

Qty: 1

- Provide unit with one additional polycarbonate container, lid and blade set

Item 124 Open Number

Item 125 POS Terminal

NIKEC – By Owner

Qty: 2

- This item is not included in the kitchen equipment contract

Item 126 Soda Gun

NIKEC – By Vendor

Qty: 2

- This item is not included in the kitchen equipment contract

Item 127 Bag In Box Rack/System

NIKEC – By Vendor

Qty: 1

- This item is not included in the kitchen equipment contract

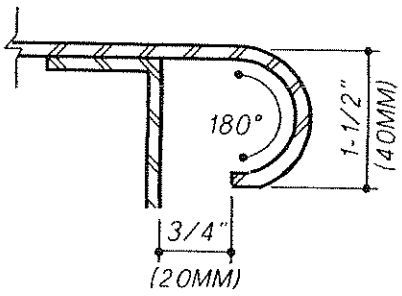
Item 128 Carbonator

NIKEC – By Vendor

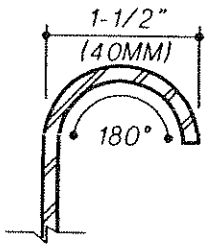
Qty: 1

- This item is not included in the kitchen equipment contract

END OF SECTION 114000



ROLLED A



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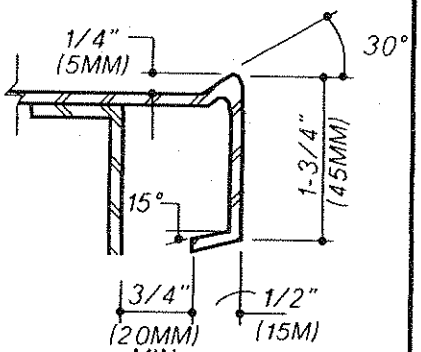

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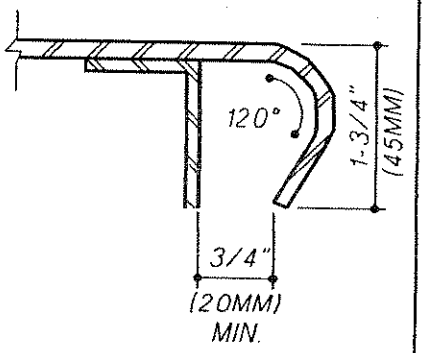

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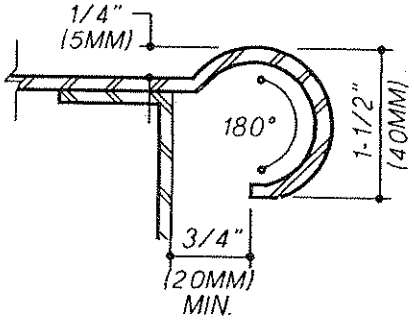

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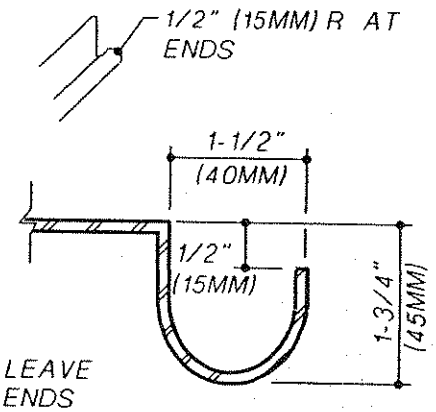
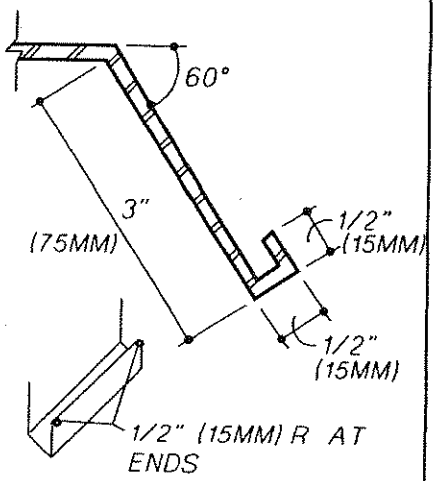
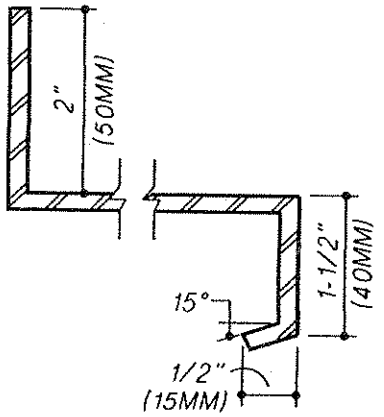


FLOUR GUTTER F

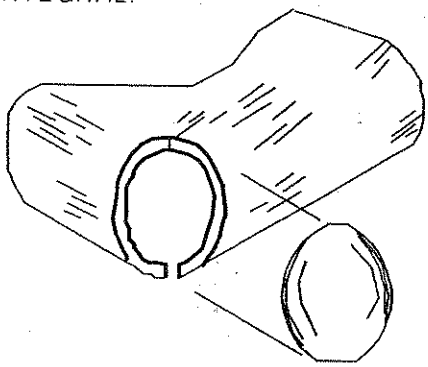


RECIPE CARD HOLDER G



UNDERSHELF H

FULLY WELD FILLER PIECE IN PLACE, GRIND SMOOTH AND POLISH TO APPEAR INTEGRAL.



STANDARD CORNER I

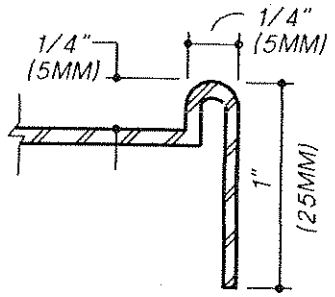
APPROVED: 11-01-02

EDGES

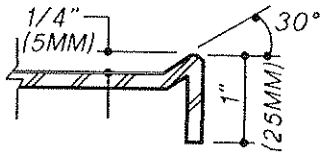
NO SCALE CONTINUED ON 1.02.1

STANDARD DETAIL

1.02

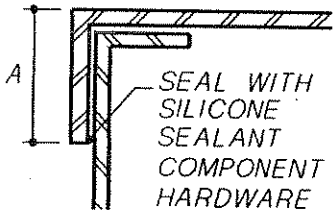


ROLLED RAISED OPENING J

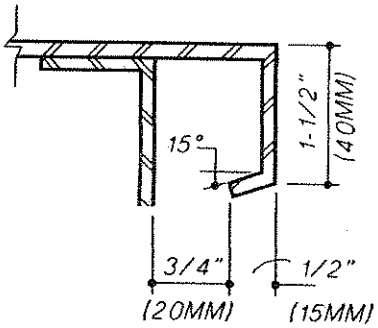


INVERTED "V"
RAISED OPENING K

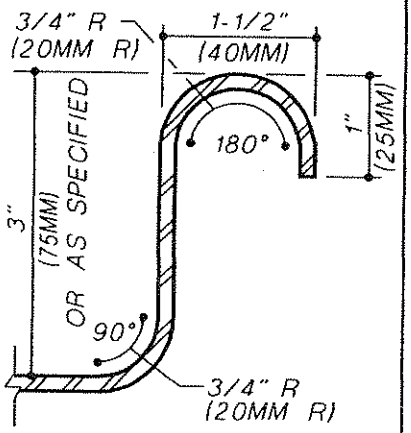
A. AS SPECIFIED. TO MATCH ADJACENT EDGES.



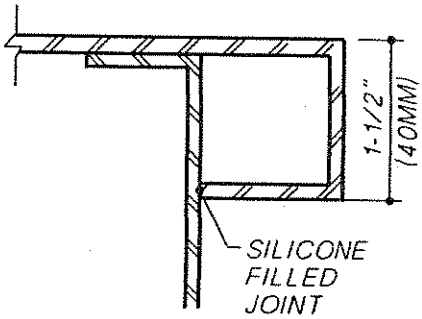
STRAIGHT TURN DOWN L



TURNED DOWN M



UP & ROLLED N



BOXED O

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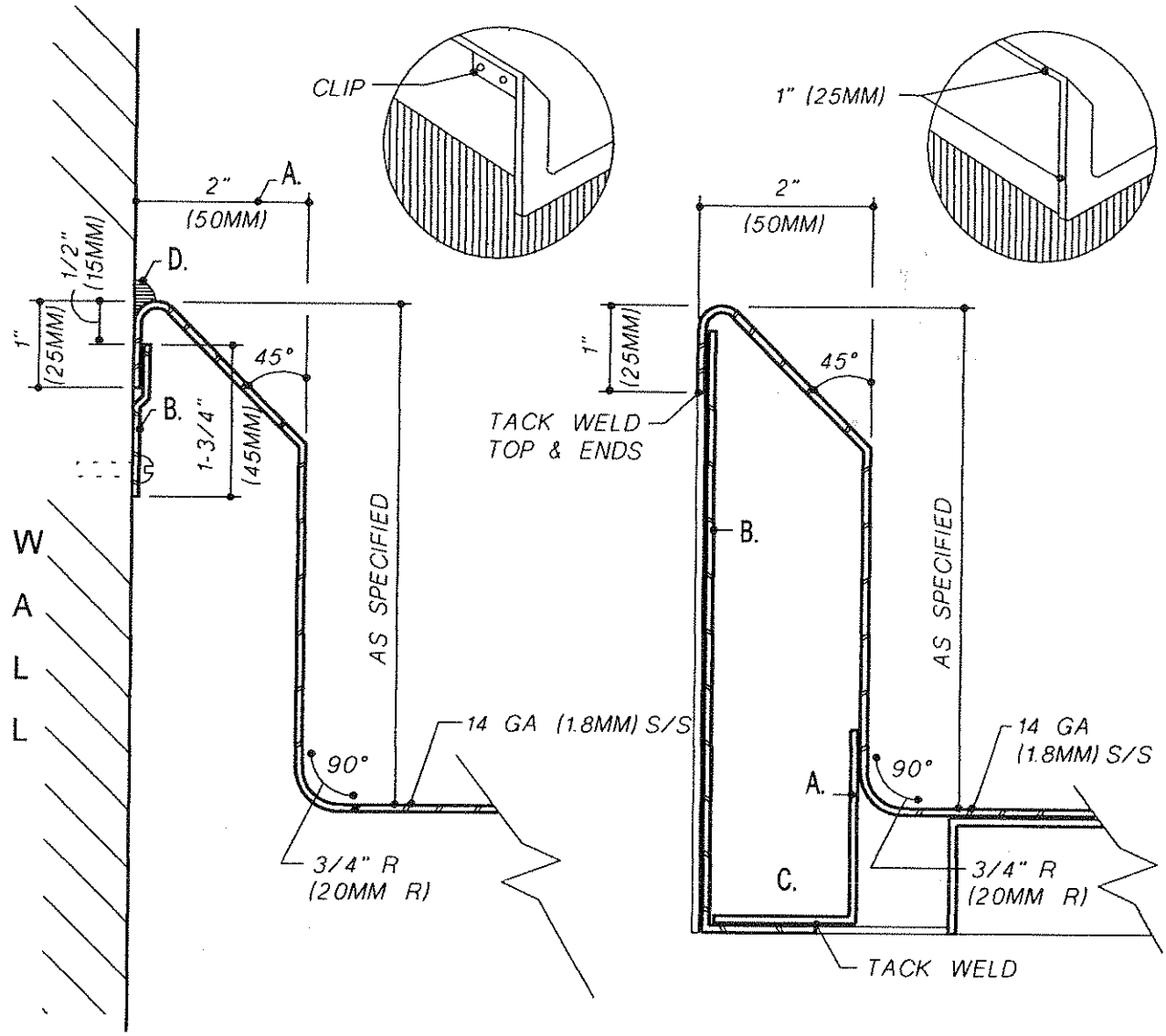
EDGES (CONTINUED)

NO SCALE SEE ALSO 1.02

STANDARD DETAIL

1.02.1



WALL UNIT-A

A. 2-1/2" (65MM) AT SINKS TO ALLOW FOR CONNECTED OVERFLOW.

B. 12 GA (2.6MM) S/S CLIP, 4" (100MM) LONG, FASTENED TO WALL AT EACH END OF UNIT AND 4'-0" (1200MM) O.C. SECURE TO WALL WITH A MINIMUM OF TWO. USE 1/4" (5MM) X 20 S/S BOLTS WITH TOGGLES OR EXPANSION SHIELDS.

C. EXPOSED ENDS TO BE FULLY WELDED CLOSED.

D. SEAL TO WALL ALL AROUND.

FREE STANDING UNIT-B

A. 2-1/2" X 1-1/2" (65MM X 40MM) 14 GA. (1.8MM) S/S CLIP WELDED TO SPLASH. RUN FULL LENGTH

B. 18 GA (1.2MM) S/S PANEL TACK WELD TO CLIPS AND SPLASH.

C. EXPOSED ENDS TO BE FULLY CLOSED.

NOTE: IF ACCESS TO SPLASH ON DETAIL B IS REQUIRED FOR ELECTRICAL OR PLUMBING, USE REMOVABLE PANEL AS SHOWN ON STANDARD DETAIL 1.04.1

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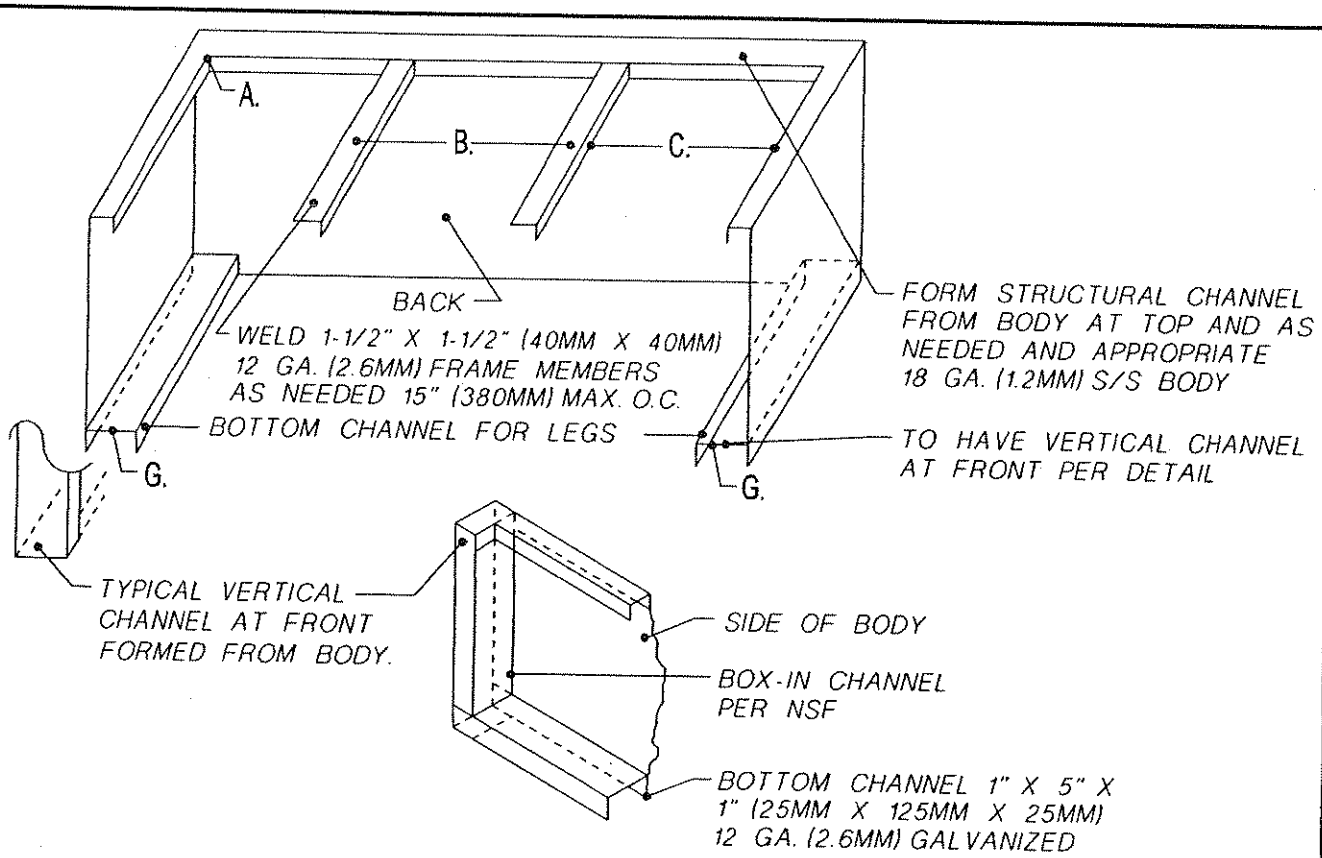
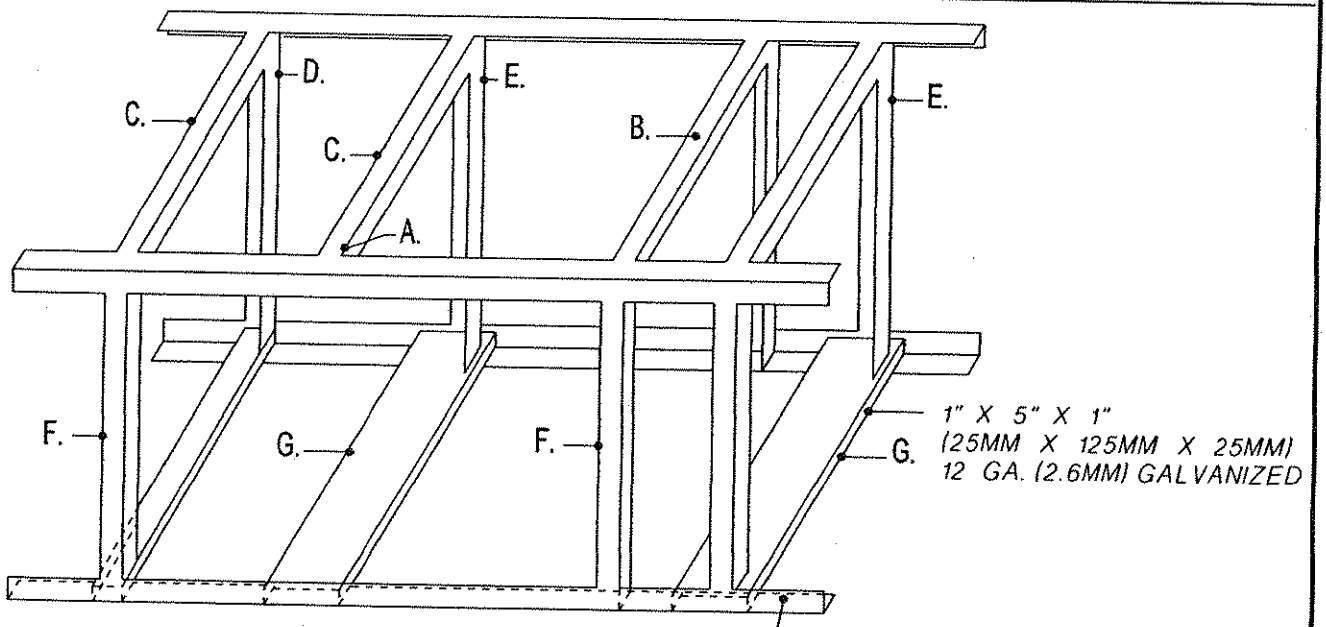
	BACKSPLASHES NO SCALE CONTINUED ON 1.04.1	STANDARD DETAIL 1.04



DETAIL OF FRONT VERTICAL CHANNEL

FRAMING FOR STRUCTURALLY FORMED CABINET BODY

A



BOX FRAME FOR PANEL CABINET BODY

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COUNTER FRAMEWORK

NO SCALE

CONTINUED ON 1.06.1

STANDARD DETAIL

1.06

A. FULLY WELDED CONSTRUCTION.

B. SECURE TOP TO FRAMEWORK WITH WELDED STUDS, S/S LOCKWASHERS, AND S/S CAP NUTS. MAXIMUM 15" (380MM) ON CENTER.

C. TOP ANGLE LOCATION - ENDS; SIDES OF TOP INSERTS; UNDER HEAVY EQUIPMENT LEGS; INTERMEDIATES 24" (380MM) ON CENTER.

D. BACK ANGLE LOCATION - ENDS; INTERMEDIATE MAXIMUM 5'-6" (1650MM) ON CENTER

E. CAFETERIA FRONT ANGLE (CHANNEL) LOCATION - ENDS; INTERMEDIATES TO CORRESPOND TO PILASTERS, TRAY SLIDE BRACKETS, BREATH PROTECTORS, DISPLAY SHELVES PANEL SPACING, MAXIMUM 4'-0" (1200MM) ON CENTER. RE: STANDARD DETAILS. 4.01 THRU 4.04.

F. WORK SIDE LOCATION - ENDS; SIDE OF OPENINGS; INTERMEDIATES MAXIMUM 5'-6" (1650MM) ON CENTER.

G. BOTTOM LEG CHANNEL LOCATION - ENDS; INTERMEDIATES CORRESPOND TO FRONT PANEL SPACING; PILASTERS, SLIDE BRACKETS. MAXIMUM 5'-6" (1650MM) ON CENTER.

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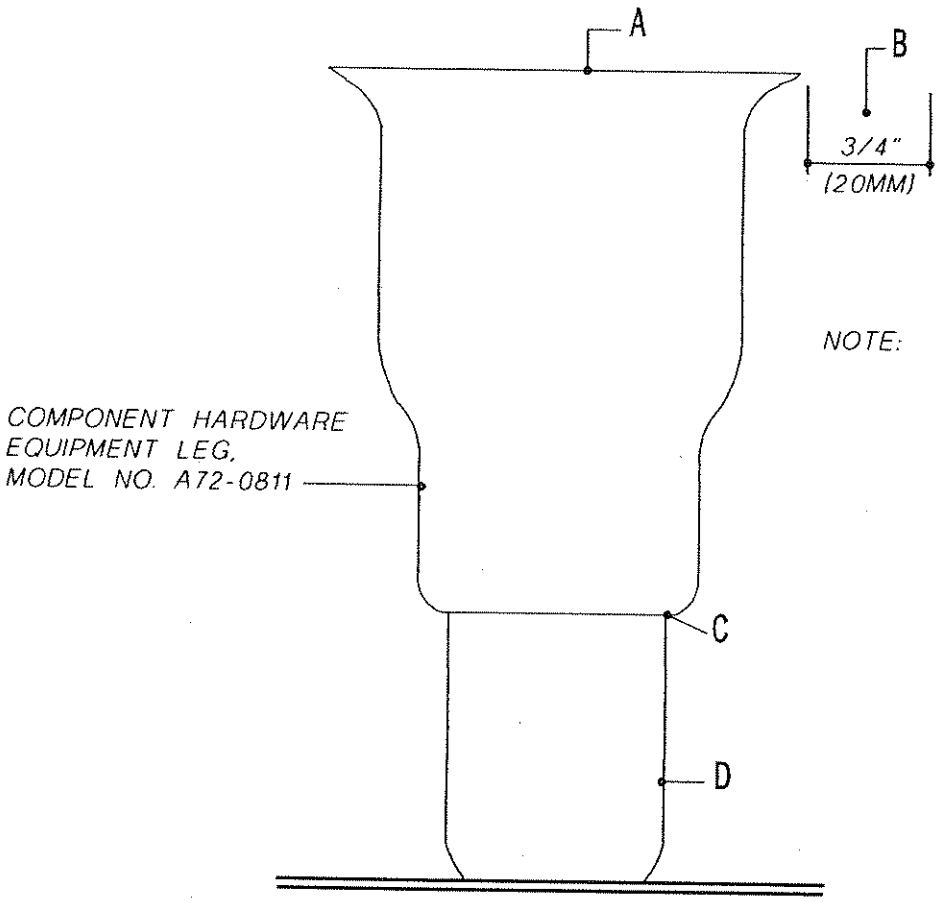
COUNTER FRAMEWORK (CONT'D)

NO SCALE SEE ALSO 1.06

STANDARD DETAIL

1.06.1



NOTE: ENTIRE FINISHED STRUCTURE AND INDIVIDUAL COMPONENTS TO MEET NSF REQUIREMENTS MAINTAIN 6" (150MM) MINIMUM CLEARANCE BETWEEN FINISHED STRUCTURE & FLOOR

A. FULLY WELD TO FRAMEWORK CHANNEL.

B. 3/4" (20MM) MINIMUM CLEARANCE ALL AROUND.

C. MAXIMUM 1/32" (1MM) CLEARANCE BETWEEN LEG AND FOOT.

D. FOOT SET AT MIDPOINT TO ALLOW 1" (25MM) ADJUSTMENT UP AND 1" (25MM) DOWN. WITHOUT THREAD EXPOSURE.

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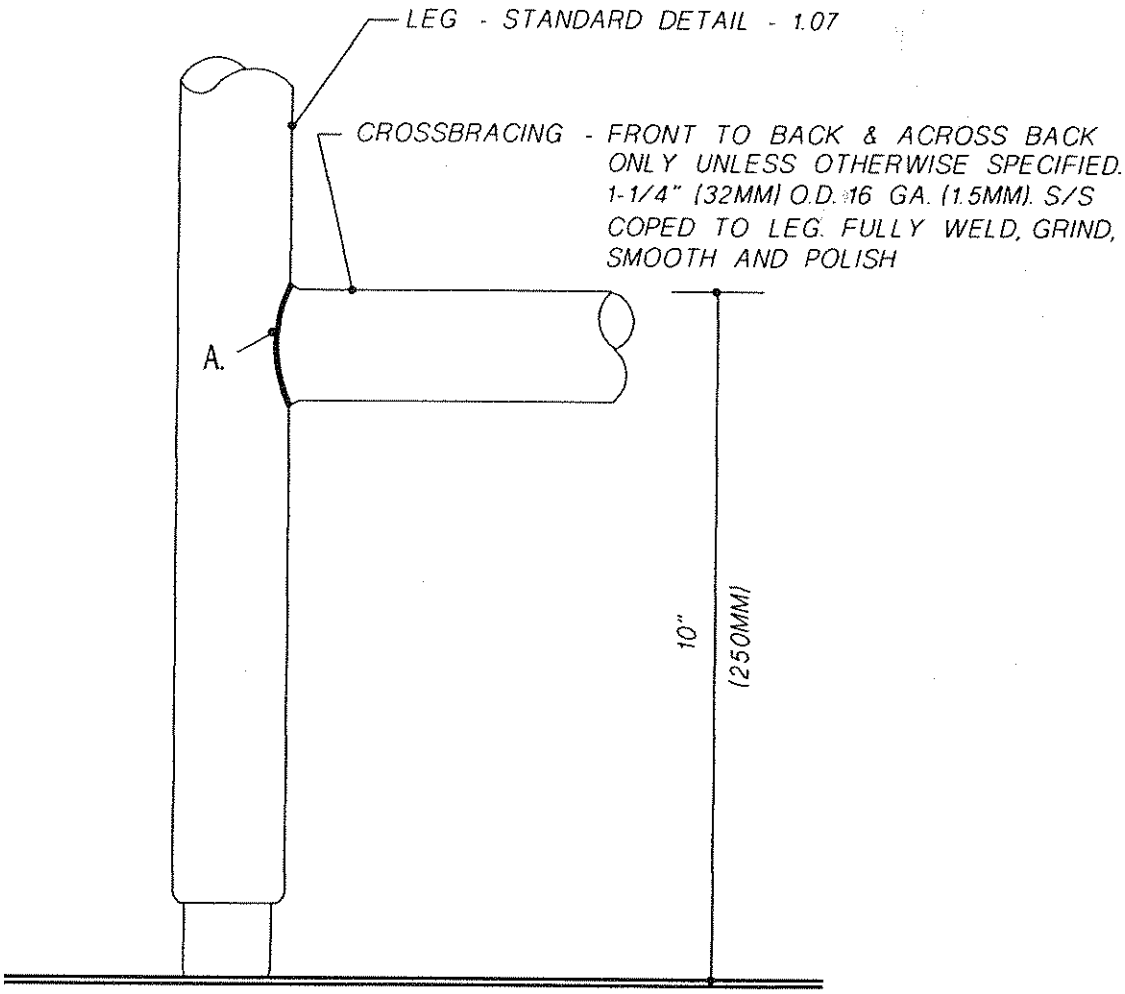
COUNTER LEGS

NO SCALE

STANDARD DETAIL

1.08



A. FULLY WELD, GRIND SMOOTH AND POLISH.

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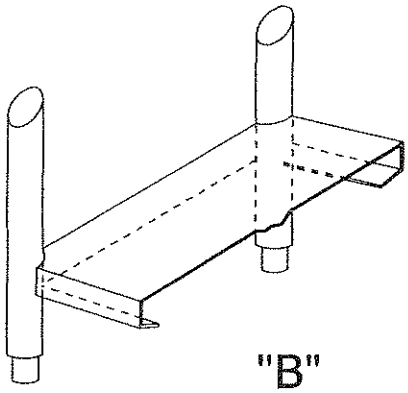
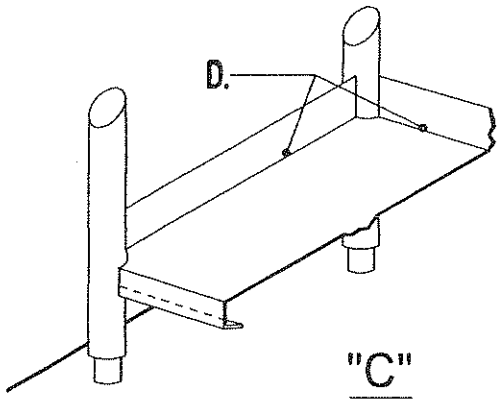
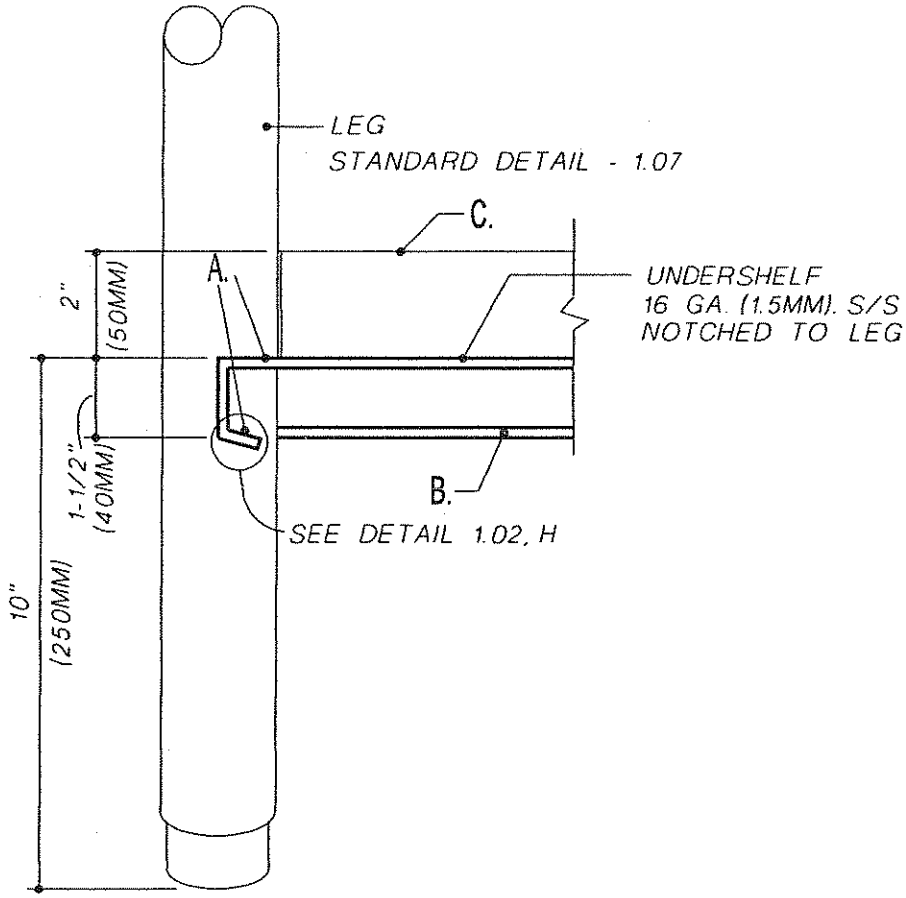
	CROSSBRACING NO SCALE CONTINUED ON 1.10.1 SEE ALSO 1.07	STANDARD DETAIL 1.10



"B"



"C"



A. FULLY WELD, GRIND SMOOTH AND POLISH, WHEREVER SHELF INTERSECTS LEGS.

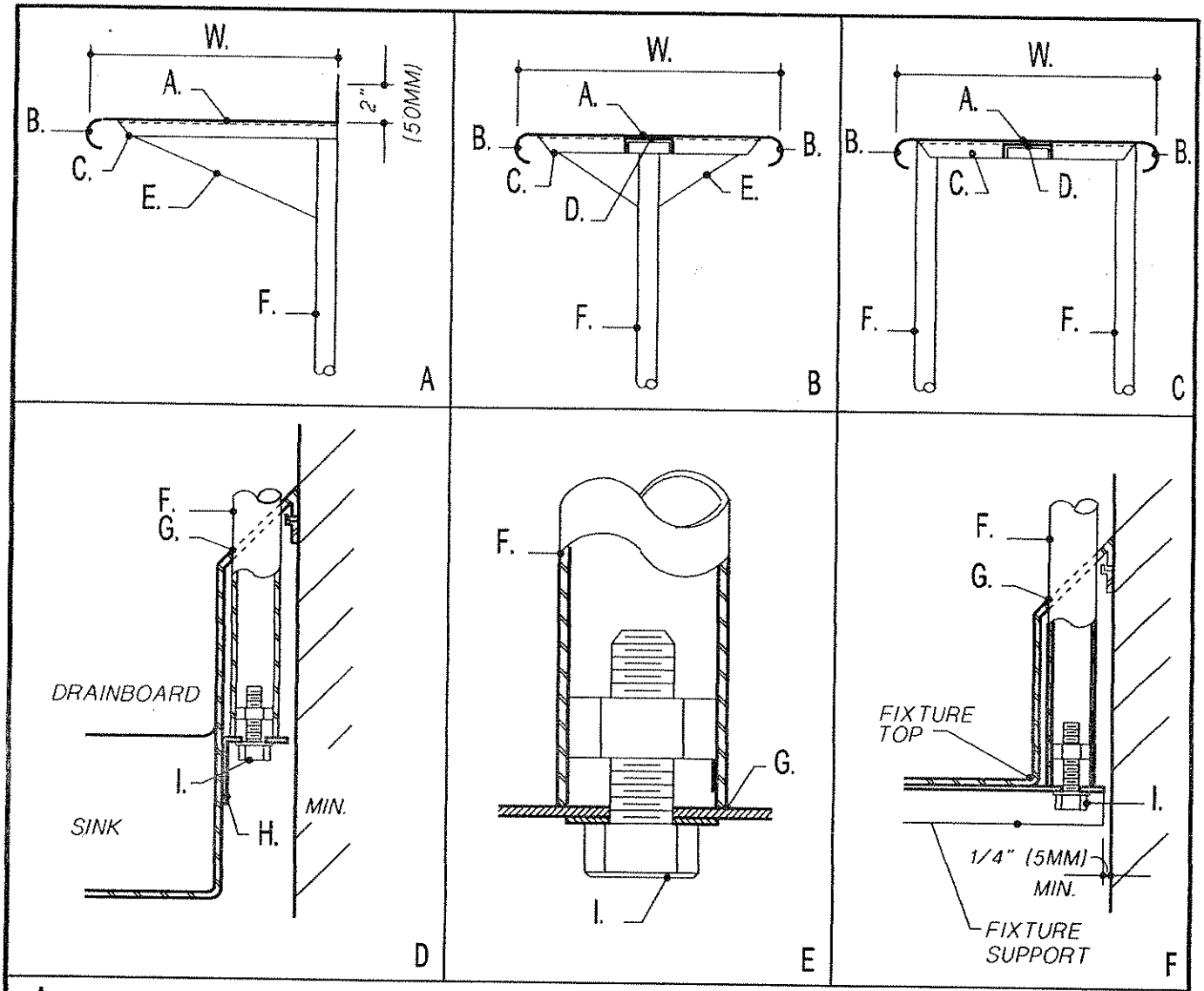
B. ON ISLAND TABLES, TURN DOWN ALL SIDES AS SHOWN IN "B" UNLESS OTHERWISE SPECIFIED.

C. ON TABLES AGAINST WALLS, TURN REAR AND ENDS UP 2" (50MM) AS SHOWN IN "C" UNLESS OTHERWISE SPECIFIED.

D. COVED BEND ACCEPTABLE, BUT NOT REQUIRED.

APPROVED: 11-01-02

UNDERSHELF	STANDARD DETAIL
NO SCALE — SEE ALSO 1.07	1.11



A. 16 GA. (1.5MM) S/S SHELF.

B. STANDARD DETAIL - 1.02 EDGE AS SPECIFIED.

C. 1" X 3" X 1" (25MM X 75MM X 25MM) 14 GA. (1.8MM) S/S CHANNEL WITH CHAMFERED ENDS.

D. 1" X 3" X 1" (25MM X 75MM X 25MM) 14 GA. (1.8MM) S/S LENGTHWISE CHANNEL WHEN LENGTH BETWEEN SUPPORTS EXCEEDS 42" (1050MM).

E. 14 GA. (1.8MM) S/S BRACKETS FULLY WELDED TO SUPPORT AND CHANNEL.

F. 1" (32MM) O.D. 16 GA. (1.5MM) S/S UPRIGHT. MAXIMUM 5'-0" (1525MM) ON CENTER.

G. TIGHT FIT & SEAL.

H. 1-1/2" X 1-1/2" (40MM X 40MM) 12 GA. S/S CLIPS WELDED TO REAR OF SINK AT DRAINBOARD HEIGHT W/HOLE FOR BOLT TO SECURE UPRIGHT.

I. 3/8" (10MM) 16 GA. (1.5MM) S/S HEX HEAD BOLT, COMPONENT HARDWARE & S/S LOCKWASHER W/ J58-0014 PLATED STEEL NUT. NUT WELDED IN UPRIGHT F.

W. WIDTH AS SPECIFIED.

NOTE: DETAIL E IS ONLY TO BE USED WITH DETAIL C SHELF, WHEN NO ELECTRICAL WIRING IS REQUIRED TO SHELF (MINIMUM-4 UPRIGHTS).

APPROVED: 11-01-02

OVERSHELVES AND SUPPORTS

NO SCALE

CONTINUED ON 1.12.1

STANDARD DETAIL

1.12

A. 16 GA. (1.5MM). S/S SHELF.

B. EDGE - STANDARD DETAIL - 1.02 OR AS SPECIFIED.

C. 1" X 3" X 1" (25MM X 75MM X 25MM) 14 GA. (1.8MM) S/S CROSS CHANNEL WITH CHAMFERED ENDS.

D. 1" X 3" X 1" (25MM X 75MM X 25MM) 14 GA. (1.8MM) S/S LENGTHWISE CHANNEL, WHEN LENGTH BETWEEN SUPPORTS EXCEEDS 42" (1050MM).

E. SECURE REAR LEGS PER STANDARD DETAIL - 1.12 E.

F. 1" (25MM) O.D. 16 GA. (1.5MM) S/S REAR UPRIGHTS. MAXIMUM 5'-0" (1525MM) ON CENTER.

G. TIGHT FIT & SEAL.

H. 1" (25MM) O.D. 16 GA. (1.5MM) S/S FRONT UPRIGHTS. MAXIMUM 5'-0" (1525MM) ON CENTER. WELD TO BOTTOM COUNTER FRAMING AND EXTEND UP THRU COUNTER TOP AND LOWER OVERSHELF AND FULLY WELD TO UPPER AND LOWER OVERSHELF CROSS CHANNELS AND UNDERSIDE OF COUNTER TOP. CUT 3/4" (20MM) DIAMETER HOLES IN SIDE OF UPRIGHTS AT TOP AND BOTTOM AS REQUIRED FOR PASSAGE OF FLEXIBLE ELECTRIC CONDUIT. PROVIDE GROMMETS IN HOLES.

I. HEAT LAMP AS SPECIFIED.

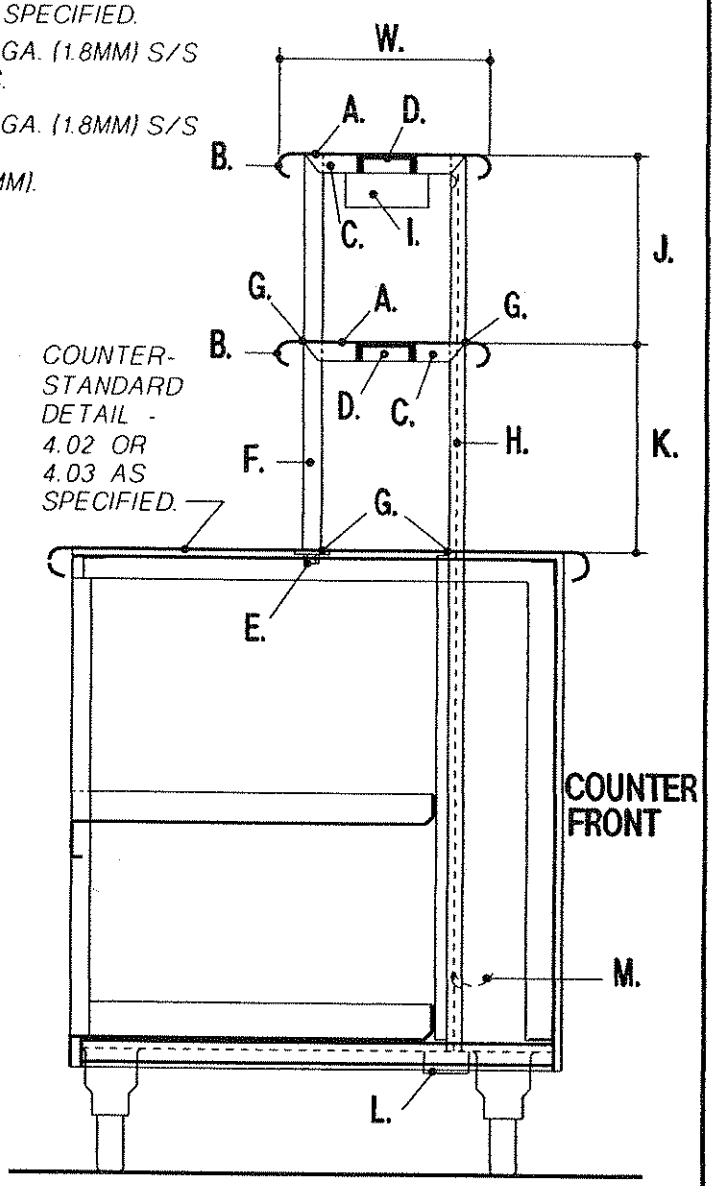
J. HEIGHT AS SPECIFIED.

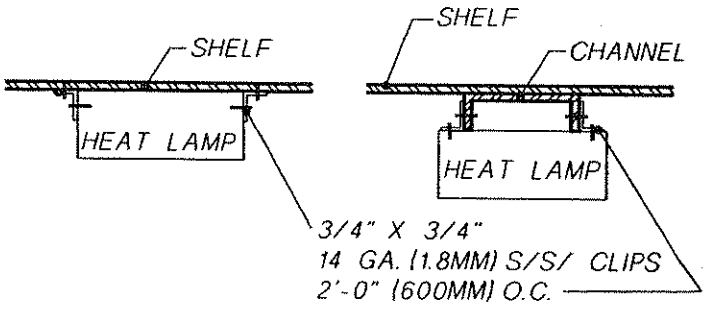
K. HEIGHT AS SPECIFIED.

L. JUNCTION BOX SECURED TO TABLE FRAMING WITH 1/4" (5MM) X 20 S/S BOLTS, LOCK WASHER, AND NUTS. DELETE IF COUNTER CONTAINS AN INTEGRAL ELECTRICAL CIRCUIT BREAKER PANEL.

M. IF COUNTER CONTAINS AN INTEGRAL ELECTRICAL CIRCUIT BREAKER PANEL, RUN WIRING OUT THRU SIDE OF FRONT UPRIGHT AND EXTEND TO PANEL.

W. WIDTH AS SPECIFIED.





NO CHANNEL BASE CHANNEL BASE

HEAT LAMP INSTALLATIONS

APPROVED: 11-01-02

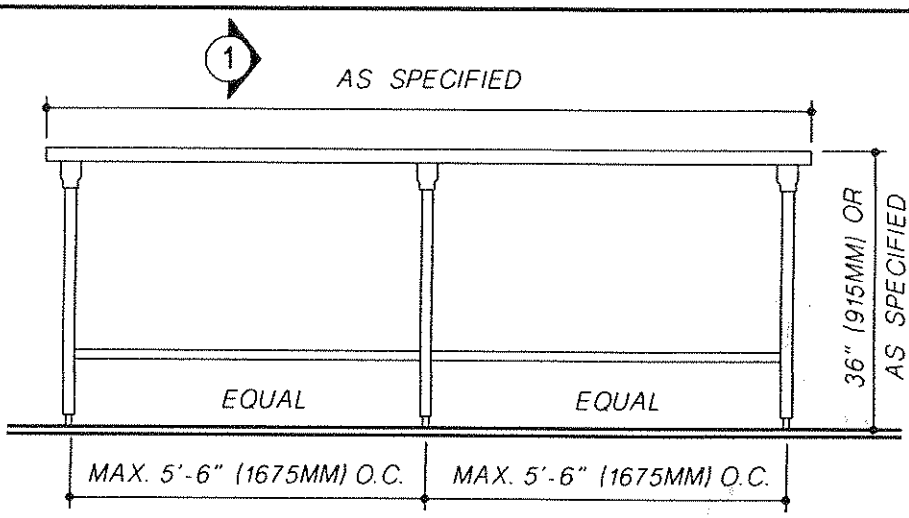
DOUBLE OVERSHELF WITH HEAT LAMP

NO SCALE

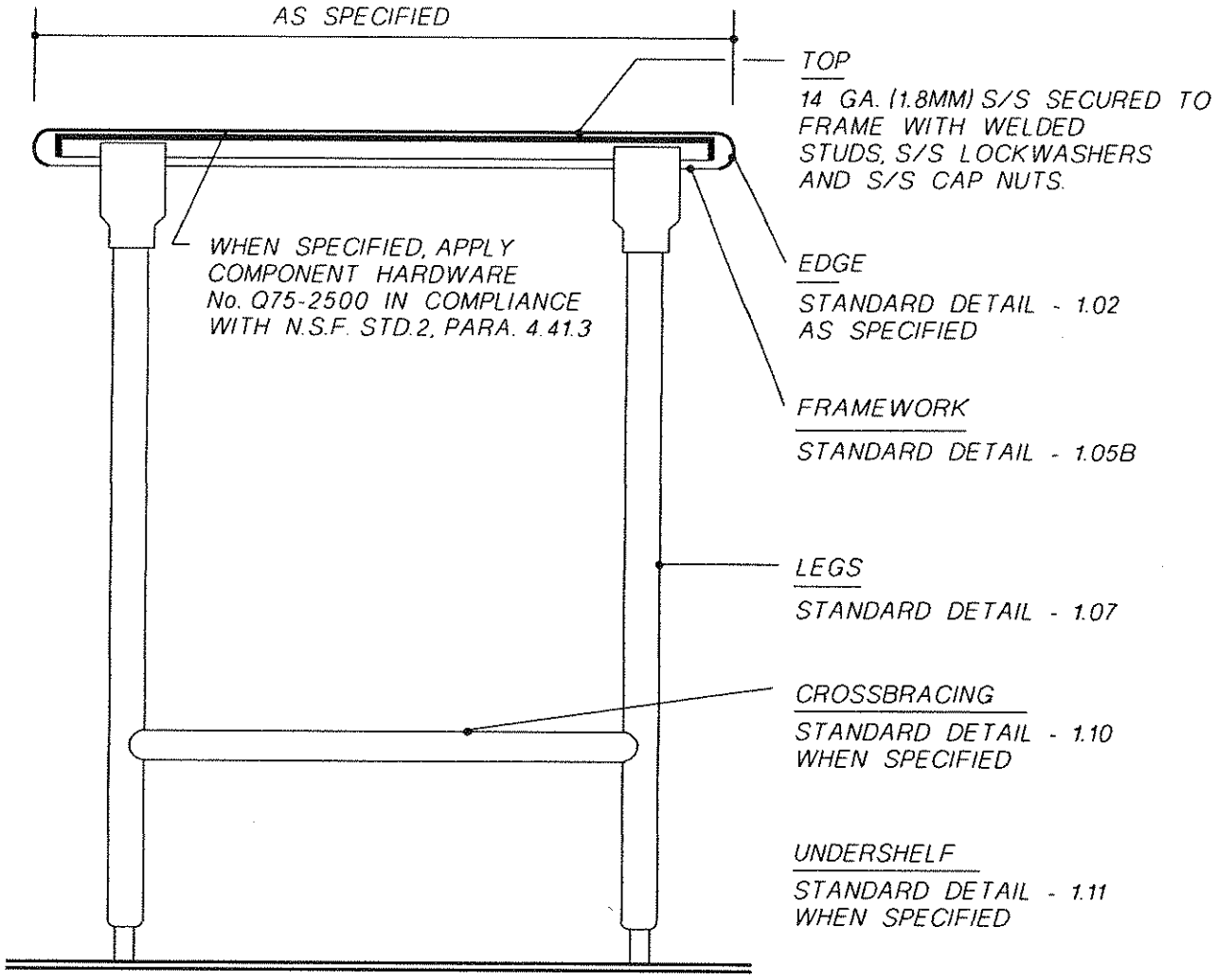
SEE ALSO 1.12, 1.02, 4.02 & 4.03

STANDARD DETAIL

1.12.1



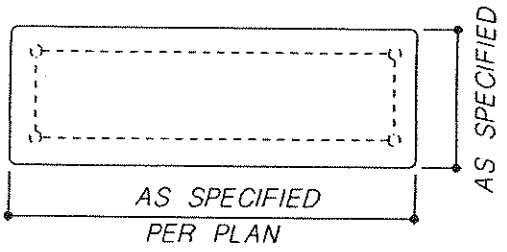
FRONT ELEVATION



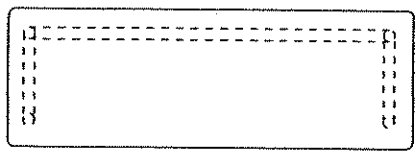
SECTION 1

APPROVED: 11-01-02

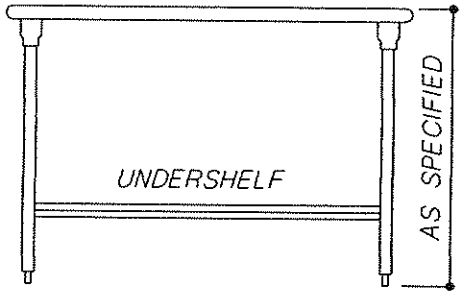
	WORK TABLE NO SCALE SEE ALSO 1.02, 1.05, 1.07, 1.10, 1.11	STANDARD DETAIL 2.01

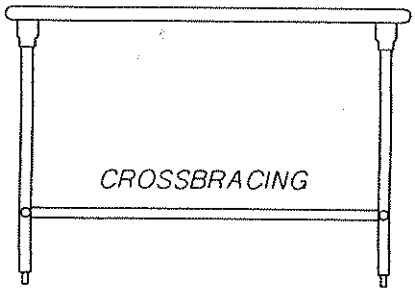


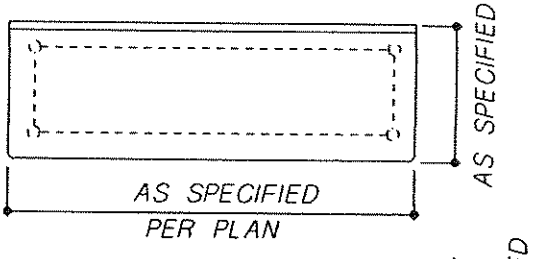
"A" ISLAND TABLE-UNDERSHELF

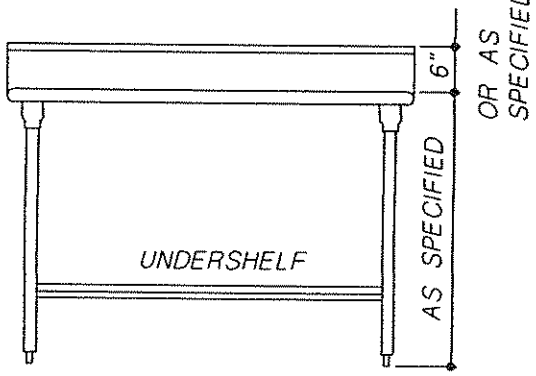


"B" ISLAND TABLE-CROSSBRACING

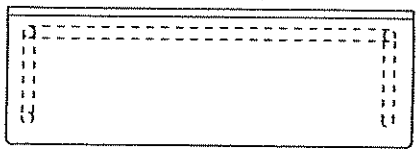


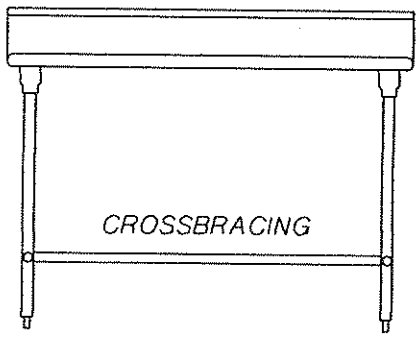






"C" TABLE W/SPLASH-UNDERSHELF





"D" TABLE W/ SPLASH-CROSSBRACING

APPROVED: 11-01-02

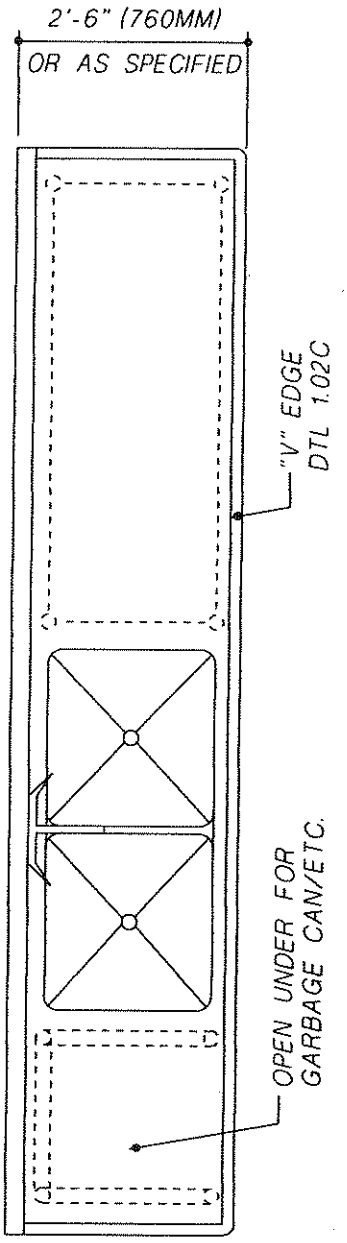
WORK TABLES-TYPE

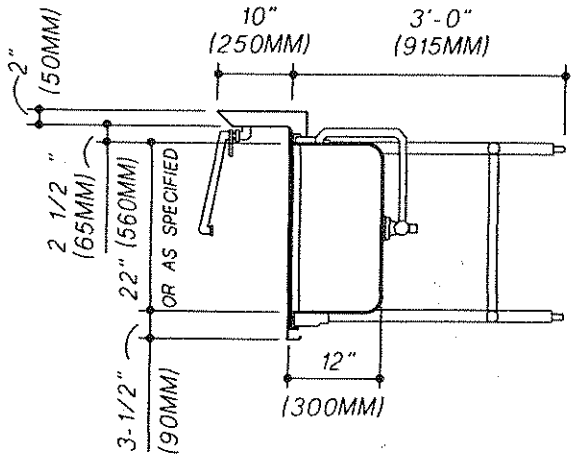
NO SCALE

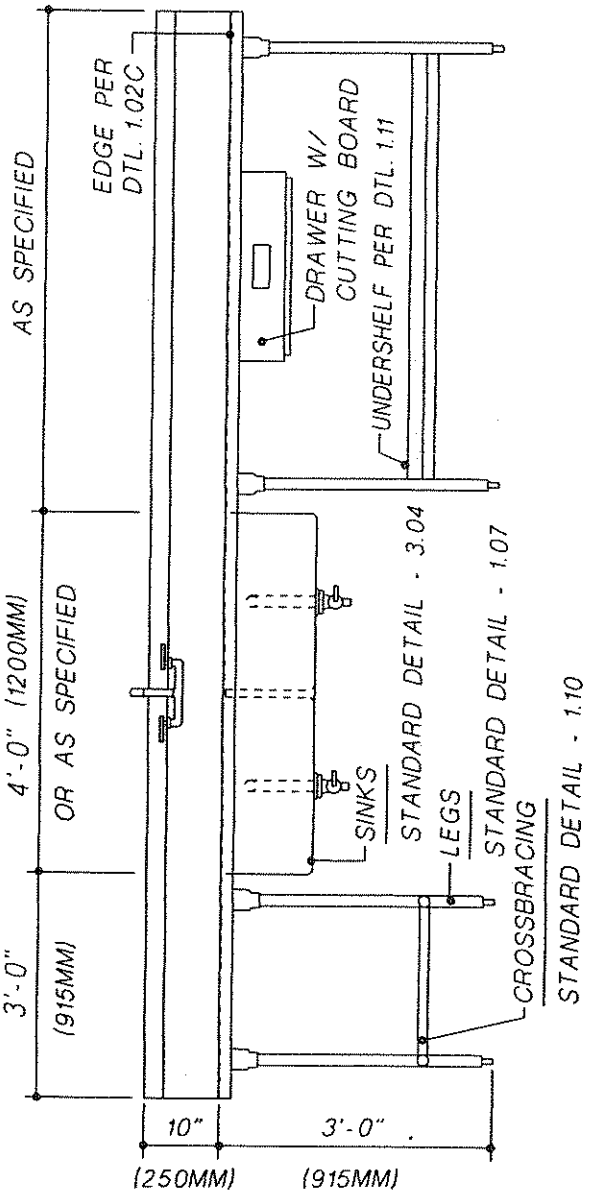
SEE ALSO 1.02, 1.05, 1.07, 1.10, 1.11

STANDARD DETAIL

2.01.1







APPROVED: 11-01-02

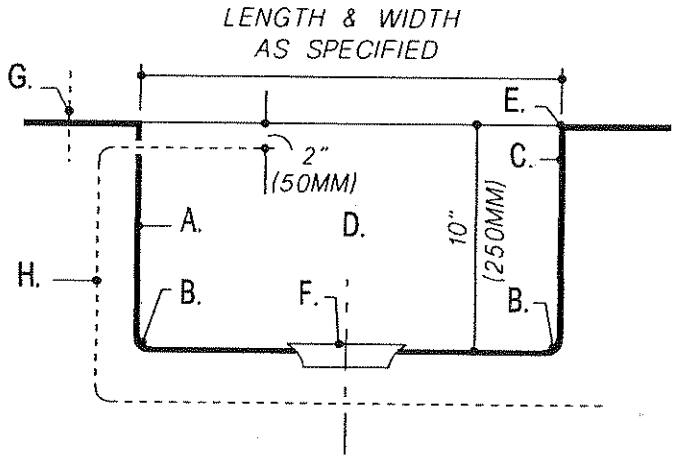
PREP. TABLE WITH SINKS

NO SCALE

SEE ALSO 1.02, 1.05, 1.07, 1.10, 1.11

STANDARD DETAIL

2.01.2



TYPICAL SECTION

A. MATERIAL - 14 GA. (1.8MM) S/S

B. ENTIRE UNIT SHALL BE ALL WELDED COVE CORNERED CONSTRUCTION WITH VERTICAL AND HORIZONTAL AND INTERIOR CORNERS HAVING A 3/4" (20MM) RADIUS. FULLY WELD SINK TO TOP. WITHOUT OVERLAPPING JOINTS.

C. TWO SIDES AND BOTTOM SHALL BE ONE CONTINUOUS PIECE WITH ENDS WELDED INTEGRAL, WITHOUT OVERLAPPING JOINTS.

D. PARTITIONS BETWEEN COMPARTMENTS TO BE DOUBLE WALL CONSTRUCTION WITH 1/2" (15MM) RADIUS ROUNDED TOP. ALL WELDED INTERGAL WITH SINK.

E. FULLY WELD SINK TO TOP WITHOUT OVERLAPPING JOINTS.

F. WASTES SHALL BE SEATED IN DIE STAMPED DEPRESSIONS WITHOUT USE OF SOLDER, RIVETS OR WELDING. INSTALLED COMPONENTS SHALL BE FLUSH WITH SURROUNDING SURFACE.

G. FAUCETS - T&S MODEL B-222 (6" NOZZLE) WITH B-199 AERATOR, REMOVABLE MONEL SEATS AND 1/2" (15MM) I.P.S. MALE INLETS. (B-221 : 12" (304MM) NOZZLE; B-220: 18" (457MM) NOZZLE)

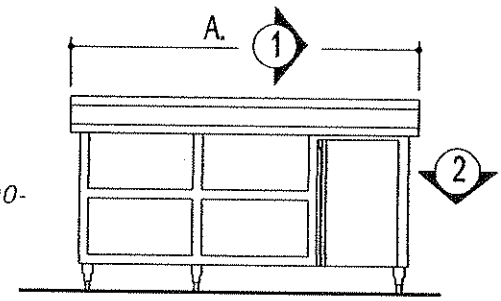
H. WASTES -2" (50MM) NICKEL PLATED BRONZE ROTARY HANDLE WASTE AND S/S STRAINER PLATE WITH CHROME PLATED BRASS CONNECTED OVERFLOW, COMPONENT HARDWARE GROUP # D50-7215

APPROVED: 11-01-02

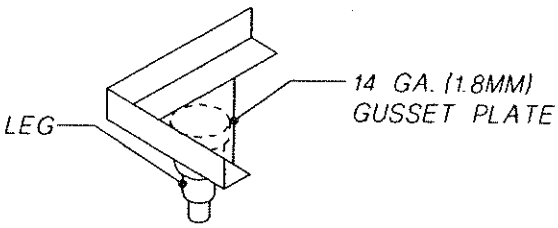
	COUNTER TOP SINKS NO SCALE	STANDARD DETAIL 3.04

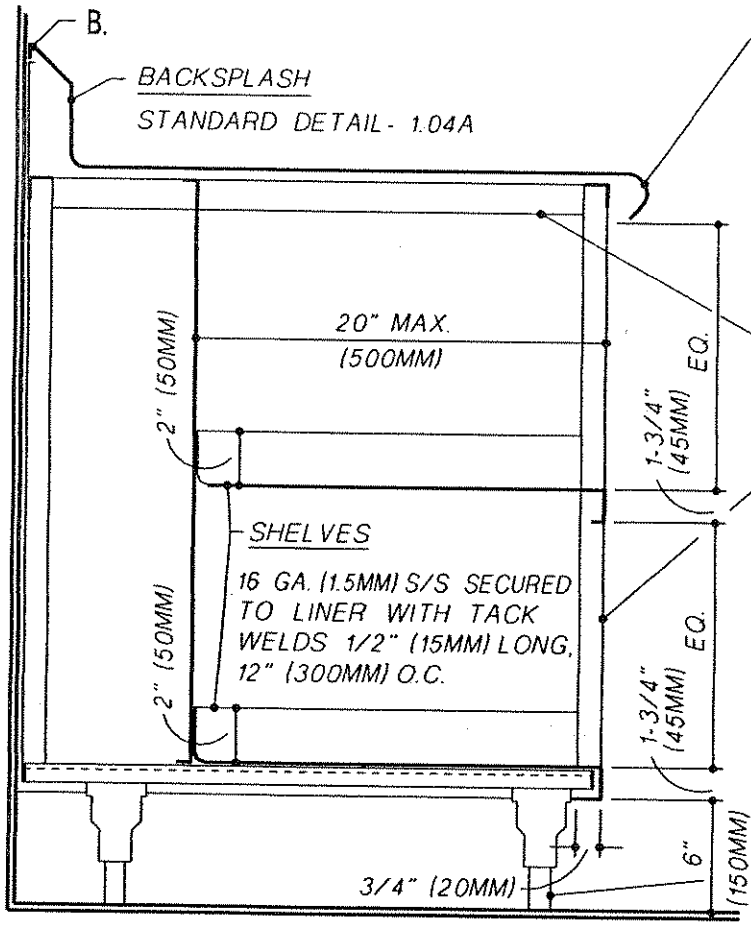
A. *SIZE AS SPECIFIED.*

B. *SEAL WITH SILICONE SEALANT, COMPONENT HARDWARE GROUP M90-SERIES (NSF).*



NOTE : POP RIVETS & EXPOSED STUDS & CAP NUTS NOT ACCEPTABLE.





EDGE

STANDARD DETAIL - 1.02 AS SPECIFIED

TOP

14 GA. (1.8MM) S/S SECURED TO FRAMEWORK WITH WELDED STUDS, S/S LOCK WASHER AND S/S CAP NUTS.

FRAMEWORK

STANDARD DETAIL - 1.06

BODY & LINER

18 GA. (1.2MM) S/S WITH INTERGRALLY FORMED STRUCTURAL ANGLES AND CHANNELS TACK WELDED, FULLY FLUSH WELD ALL EXPOSED SEAMS.

DOOR

STANDARD DETAIL - 4.25
- 4.26
- 4.27
- 4.28

LEGS

STANDARD DETAIL - 1.08

SECTION 1

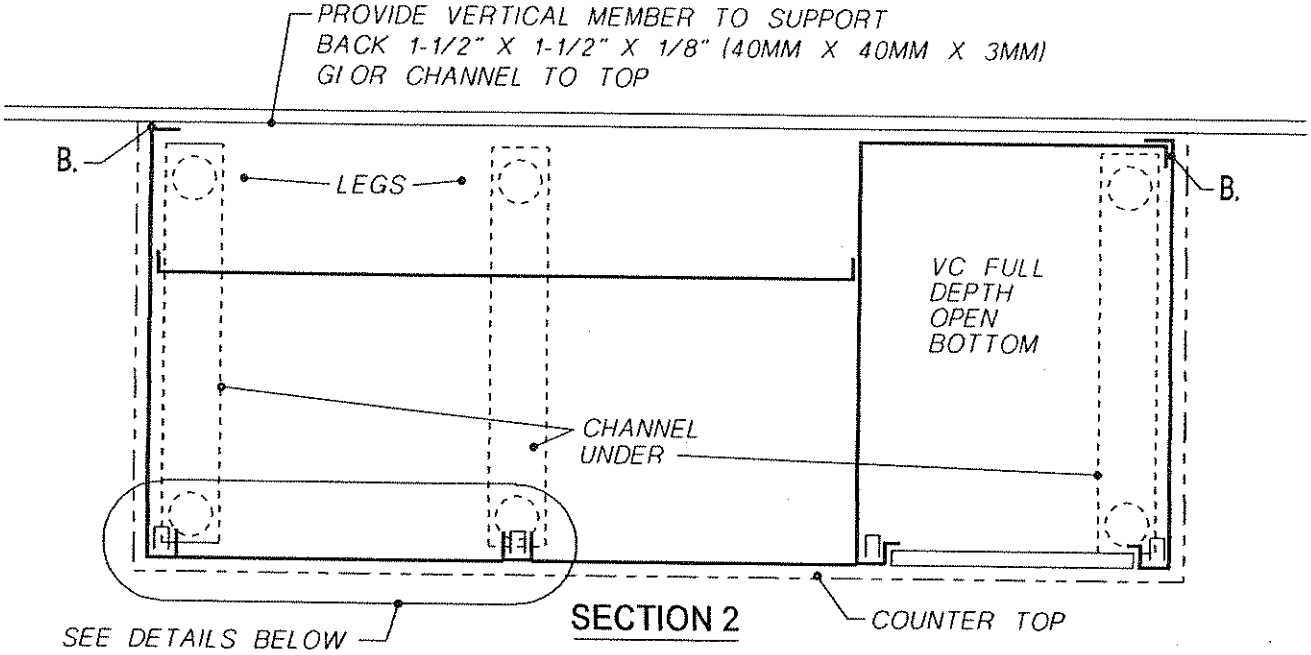
APPROVED: 11-01-02

BACK COUNTER

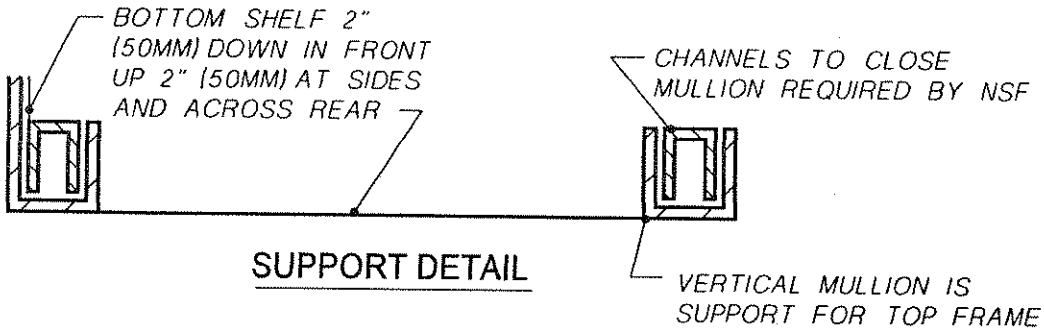
NO SCALE CONTINUED ON 4.01.1 SEE ALSO: 1.02, 1.04A, 1.06, 1.08, 4.25, 4.26, 4.27, 4.28

STANDARD DETAIL

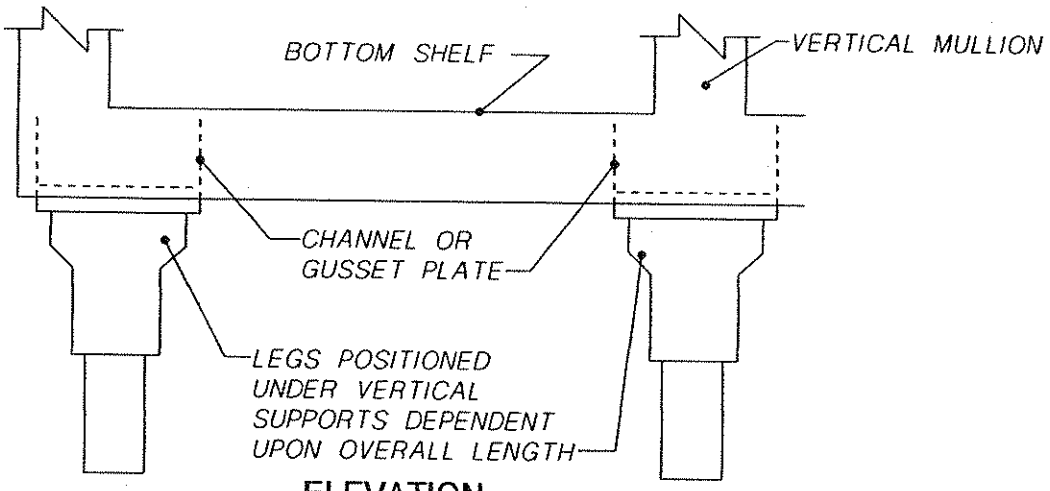
4.01



SECTION 2



SUPPORT DETAIL



ELEVATION

APPROVED: 11-01-02

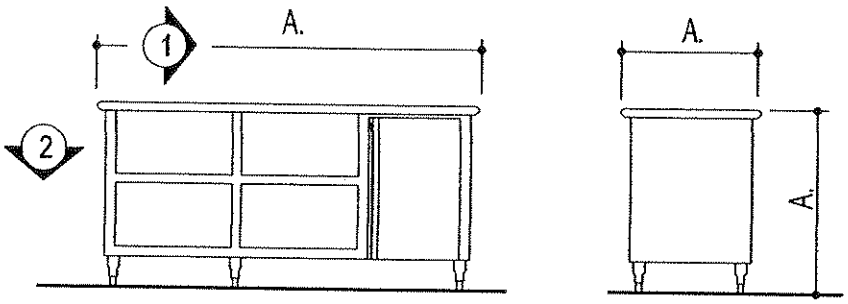
BACK COUNTER

NO SCALE

SEE ALSO: 1.02, 1.04A, 1.06, 1.08, 4.01, 4.25, 4.26, 4.27, 4.28

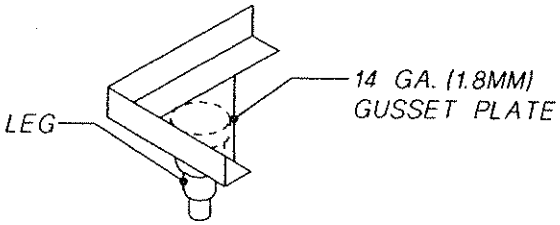
STANDARD DETAIL

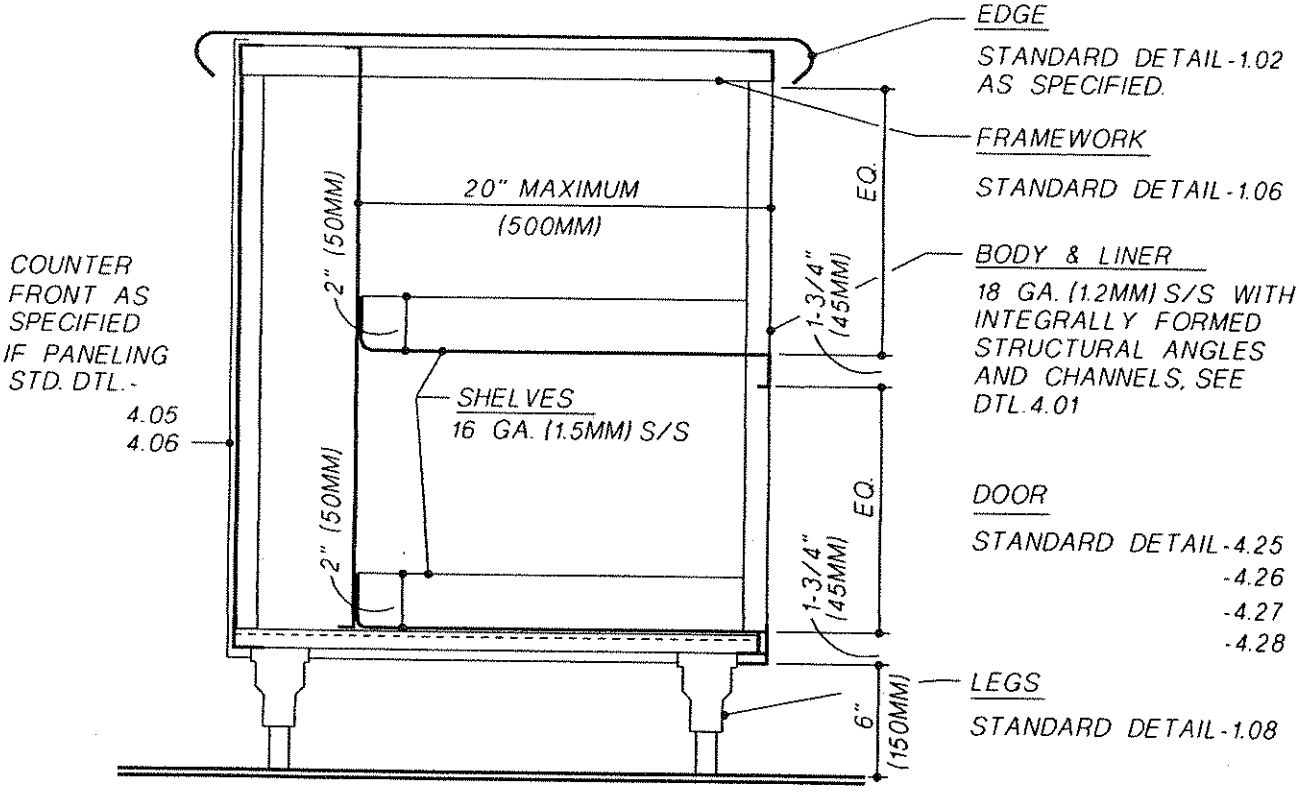
4.01.1



A. AS SPECIFIED.

B. TIGHT JOINT CLOSED BOTTOM.





SECTION 1

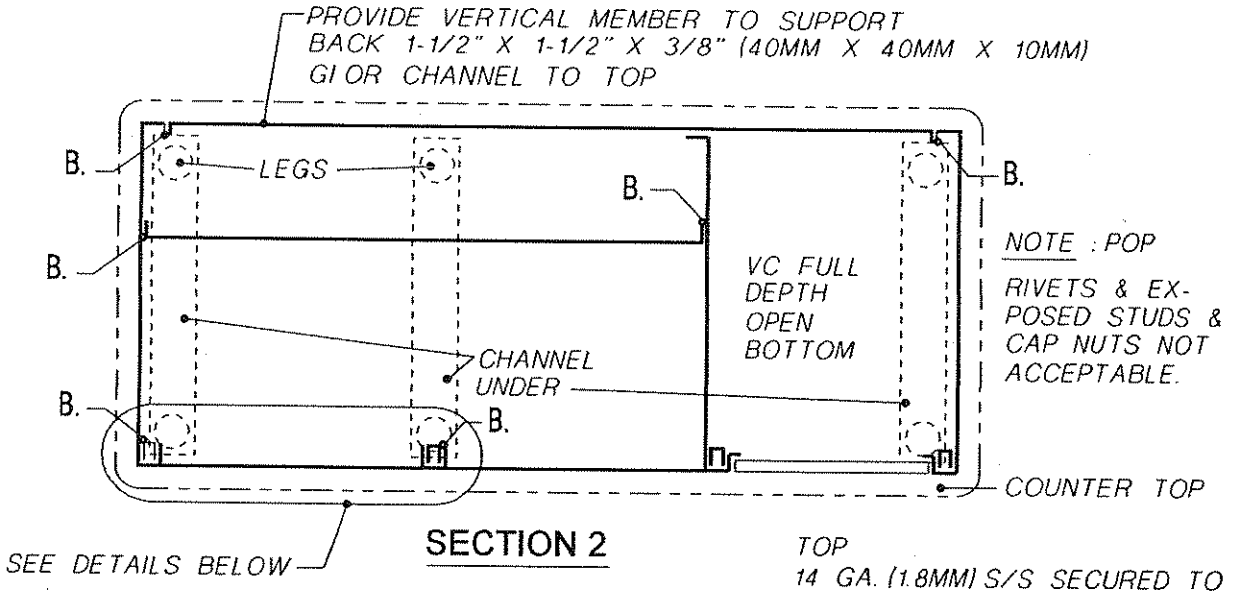
APPROVED: 11-01-02

FREE STANDING COUNTER

NO SCALE CONTINUED ON 4.02.1 SEE ALSO: 4.02.1, 1.02, 1.06, 1.08, 4.05, 4.06, 4.25, 4.26, 4.27 & 4.28

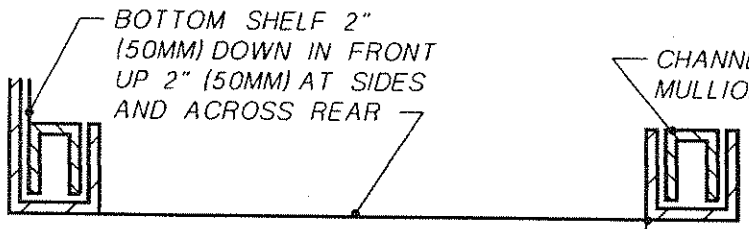
STANDARD DETAIL

4.02

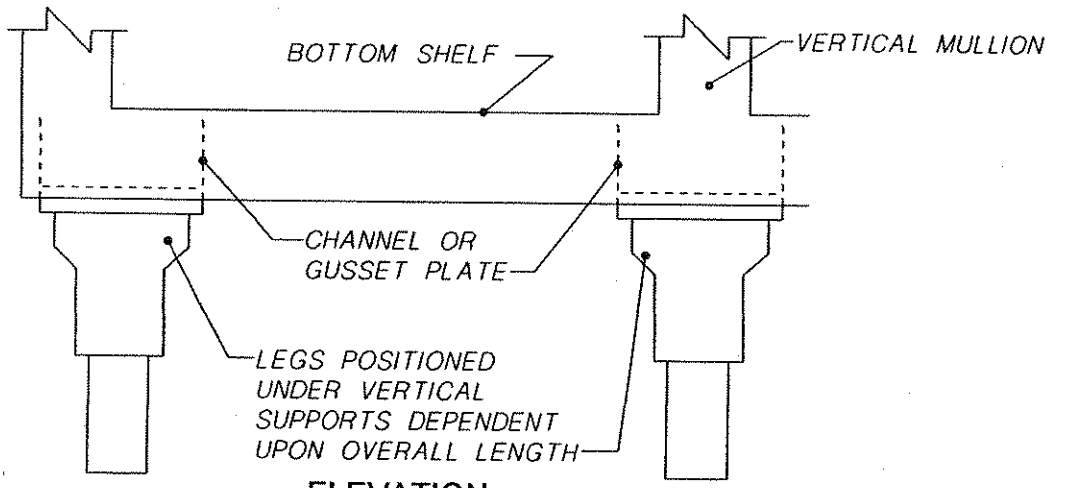


SECTION 2

TOP
14 GA. (1.8MM) S/S SECURED TO FRAMEWORK WITH WELDED STUDS, S/S L.W. AND CAP NUTS.



SUPPORT DETAIL



ELEVATION

APPROVED: 11-01-02

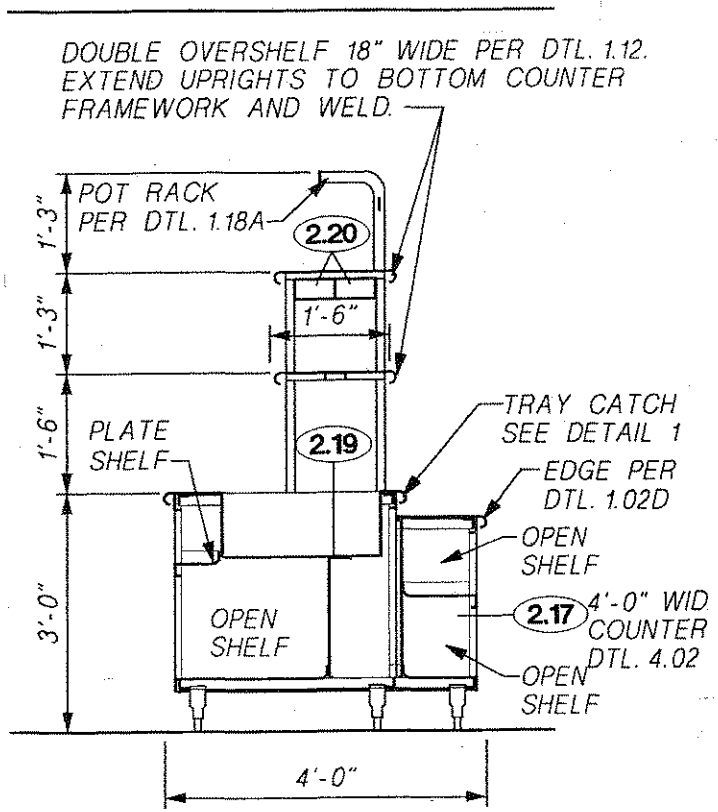
FREE STANDING COUNTER	STANDARD DETAIL
NO SCALE SEE ALSO 4.02	4.02.1

APPROVED: 11-01-02

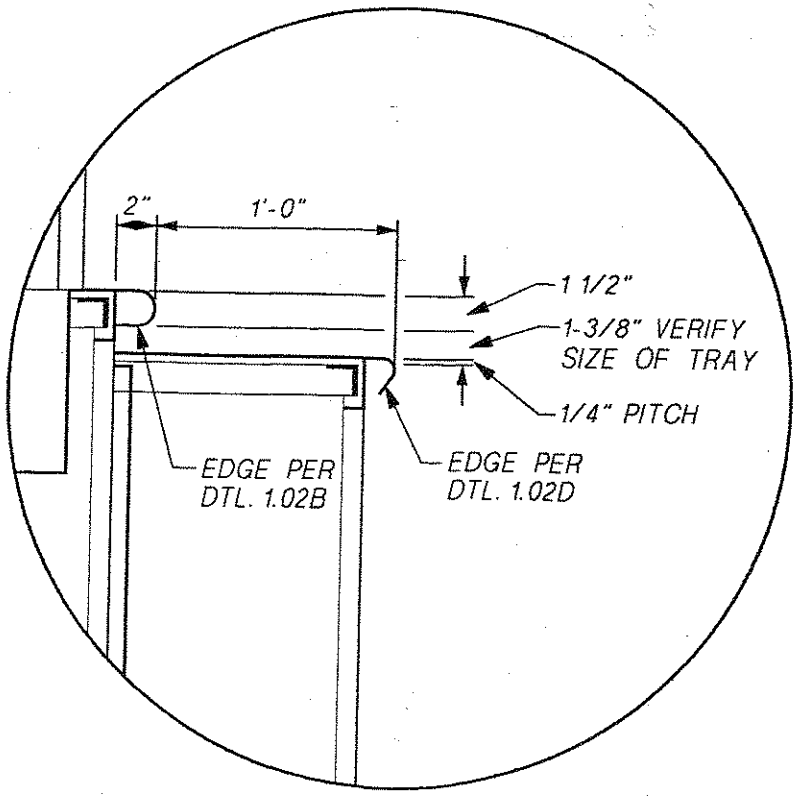
FREE STANDING COUNTER

NO SCALE SEE ALSO 4.02

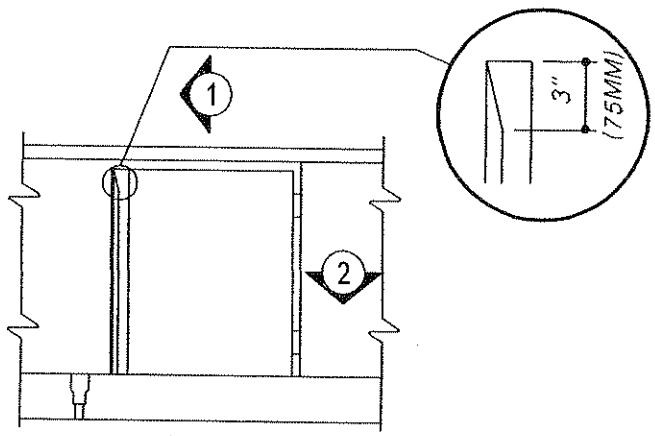
STANDARD DETAIL 4.02.2

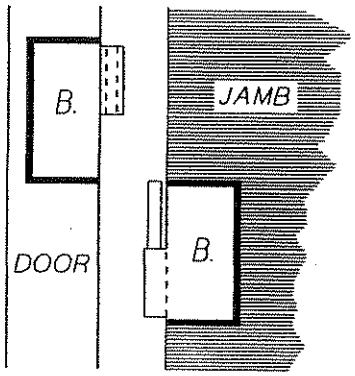


SECTION 1

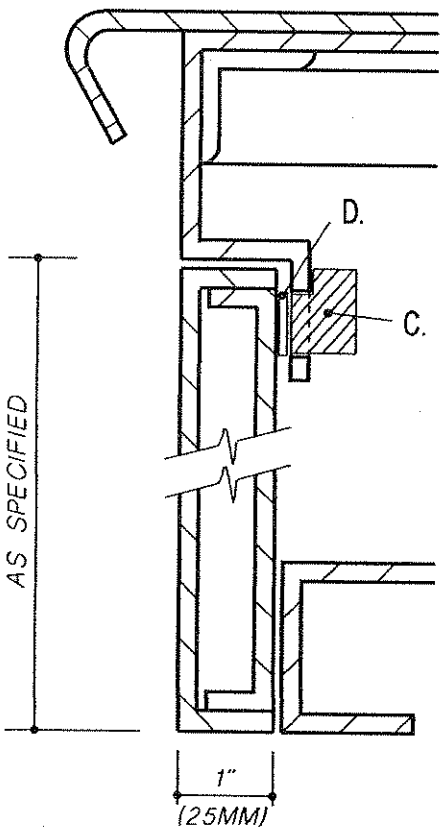


DETAIL 1

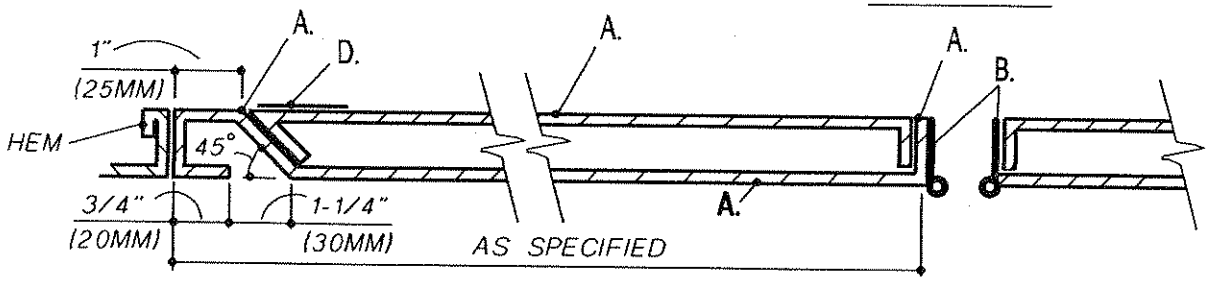




HINGE DETAIL



SECTION 1



SECTION 2

A. 18 GA. (1.2MM) S/S EXTERIOR AND INTERIOR PANS TACK WELDED.

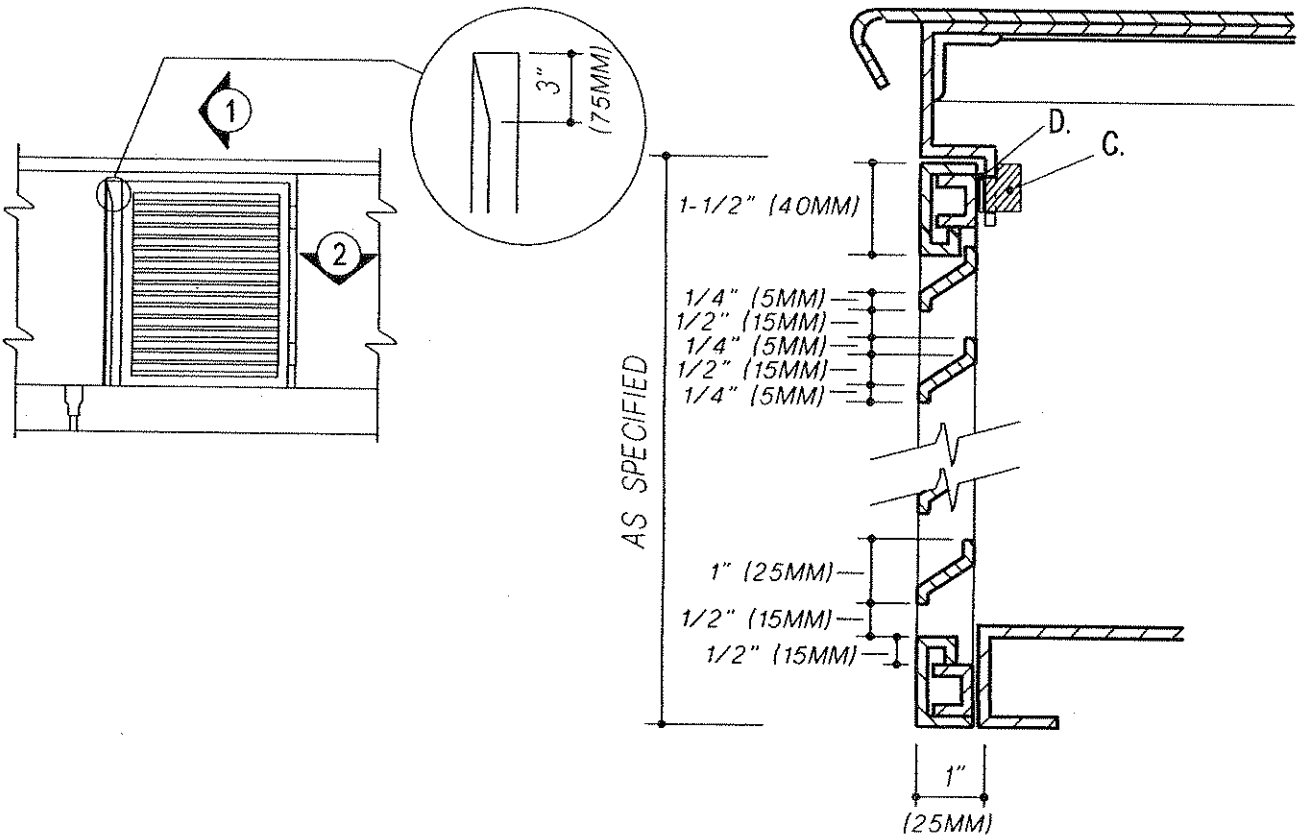
B. HEAVY-DUTY S/S SLIP JOINT HINGE, COMPONENT HARWARE GROUP R74-9000 (R.H.) OR R74-9001 (L.H.) SET IN FLUSH WITH SURFACE OF DOOR AND JAMB WELDED IN PLACE.

C. COMPONENT HARDWARE GROUP M32-2401 MAGNETIC CATCH MOUNTED FLUSH IN CUT OUT ON 1" (25MM) TURN DOWN. PROVIDE TOP AND BOTTOM CATCHES ON DOORS OVER 24" H X 24" W (610MM H X 610MM W).

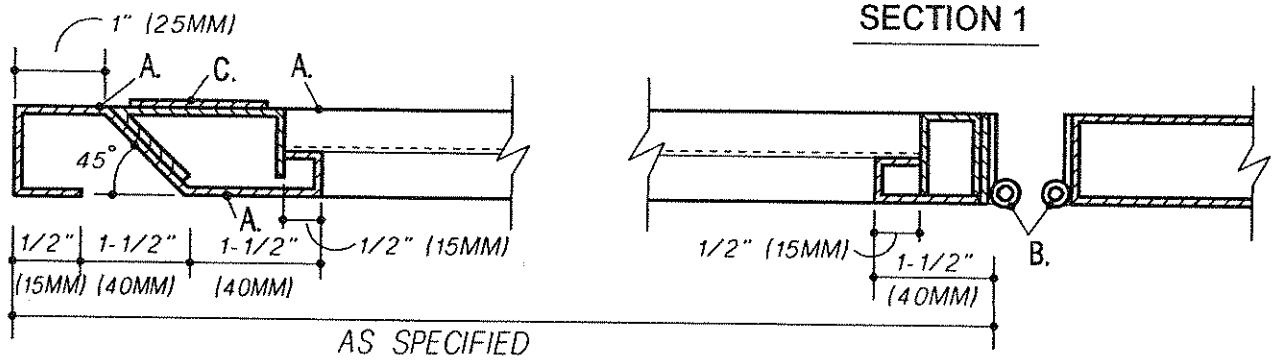
D. STEEL PLATE FOR MAGNETIC CATCH TACK WELDED TO INTERIOR DOOR PAN.

APPROVED: 11-01-02

HINGED SOLID DOOR NO SCALE	STANDARD DETAIL 4.26



SECTION 1



SECTION 2

A. CONSTRUCT INTERIOR AND EXTERIOR FRAME OF 18 GA. (1.2MM) S/S ALL FLUSH WELDED AND POLISHED. TACK WELD INTERIOR AND EXTERIOR TOGETHER TACK WELD 18 GA. (1.2MM) S/S BLADES IN POSITION, GRIND SMOOTH AMD POLISH.

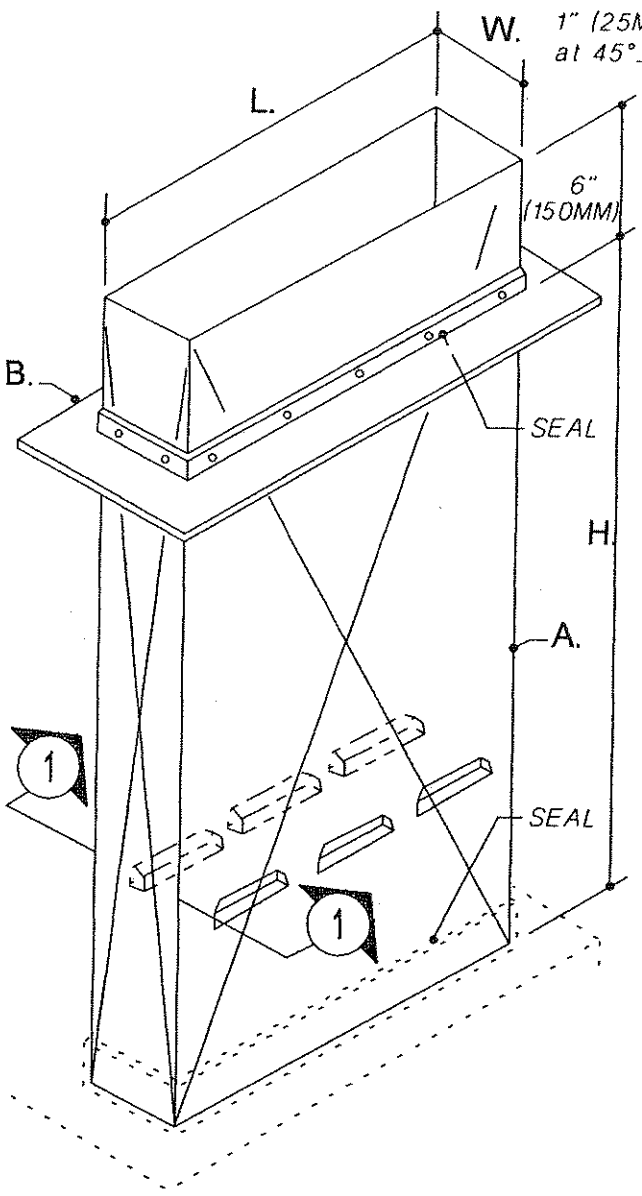
B. HEAVY-DUTY S/S SLIP JOINT HINGE COMPONENT HARDWARE GROUP R74-9000 (R.H.) OR R74-9001 (L.H.) SET IN FLUSH WITH SURFACE OF DOOR AND JAMB AND WELDED IN PLACE.

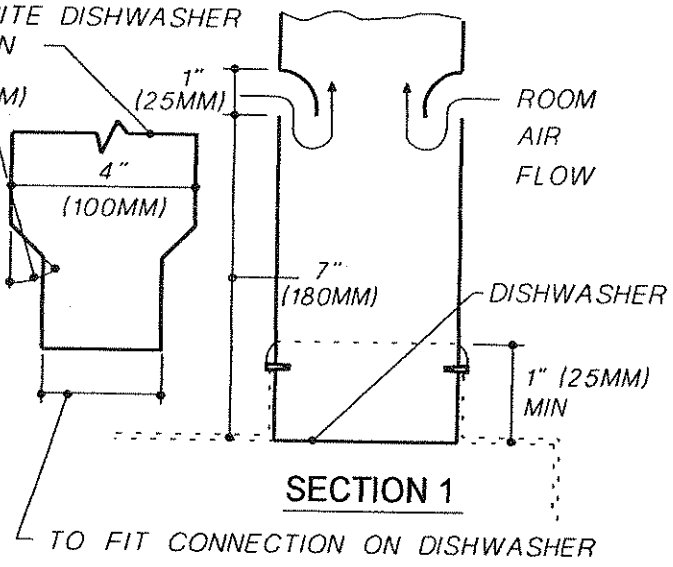
C. COMPONENT HARDWARE GROUP M32-2401 MAGNETIC CATCH MOUNTED FLUSH IN CUT OUT ON 1" (25MM) TURN DOWN. PROVIDE TOP AND BOTTOM CATCHES ON DOORS OVER 24" H X 24" W (610MM H X 610MM W).

D. STEEL PLATE FOR MAGNETIC CATCH TACK WELDED TO INTERIOR DOOR PAN.

APPROVED: 11-01-02

HINGED LOUVERED DOOR NO SCALE	STANDARD DETAIL 4.27





A. DUCT - 18 GA. (1.2MM) S/S WITH (6) 1" X 4" (25MM X 100MM) LOUVERS DIE STAMPED INWARD TO ALLOW FLOW OF COOL AIR TO ENTER DUCT AS SHOWN TO CONDENSE MOISTURE-LADEN AIR FROM DISHWASHER. DUCT TO FIT TIGHT TO INSIDE OF DISHWASHER VENT COLLAR. SECURE WITH S/S SCREWS AND SEAL WITH SILICONE.

INVERTED, OUTWARD LOUVERS AND DUCTS FITTED TO OUTSIDE OF DISHWASHER VENT SHALL NOT BE ACCEPTED.

B. CEILING TRIM - 18 GA. (1.2MM) S/S, 1"X2" (25MM X 50MM) ANGLE TRIM SECURED TO DUCT WITH S/S SCREWS AND SEALED WITH SILICONE. PERIMITER CRIMPED TO PROVIDE A HUG TIGHT EDGE TO CEILING.

H. VERIFY. DUCTS OVER 60" (1525MM) SHALL BE CROSS CREASED FOR RIGIDITY.

L. &W. VERIFY. SHALL BE TIGHT FIT WITH INSIDE OF D.W. VENT.

NOTE: 1. DISHWASHER EXHAUST REQUIREMENTS. INCREASE DISHWASHER MANUFACTURERS CFM EXHAUST REQUIREMENTS FOR EACH VENT BY 50% TO ALLOW FOR AIR INDUCTION THROUGH DUCT VENTS.

2. EXHAUST DAMPER REQUIREMENTS. WHEN D.W. VENTS ARE NOT EQUIPPED WITH DAMPERS, EACH DUCT SHALL BE PROVIDED WITH AN 18 GA. (1.2MM) S/S DAMPER AND LOCKING QUADRANT LOCATED BETWEEN THE LOUVERS AND THE D.W. VENT.

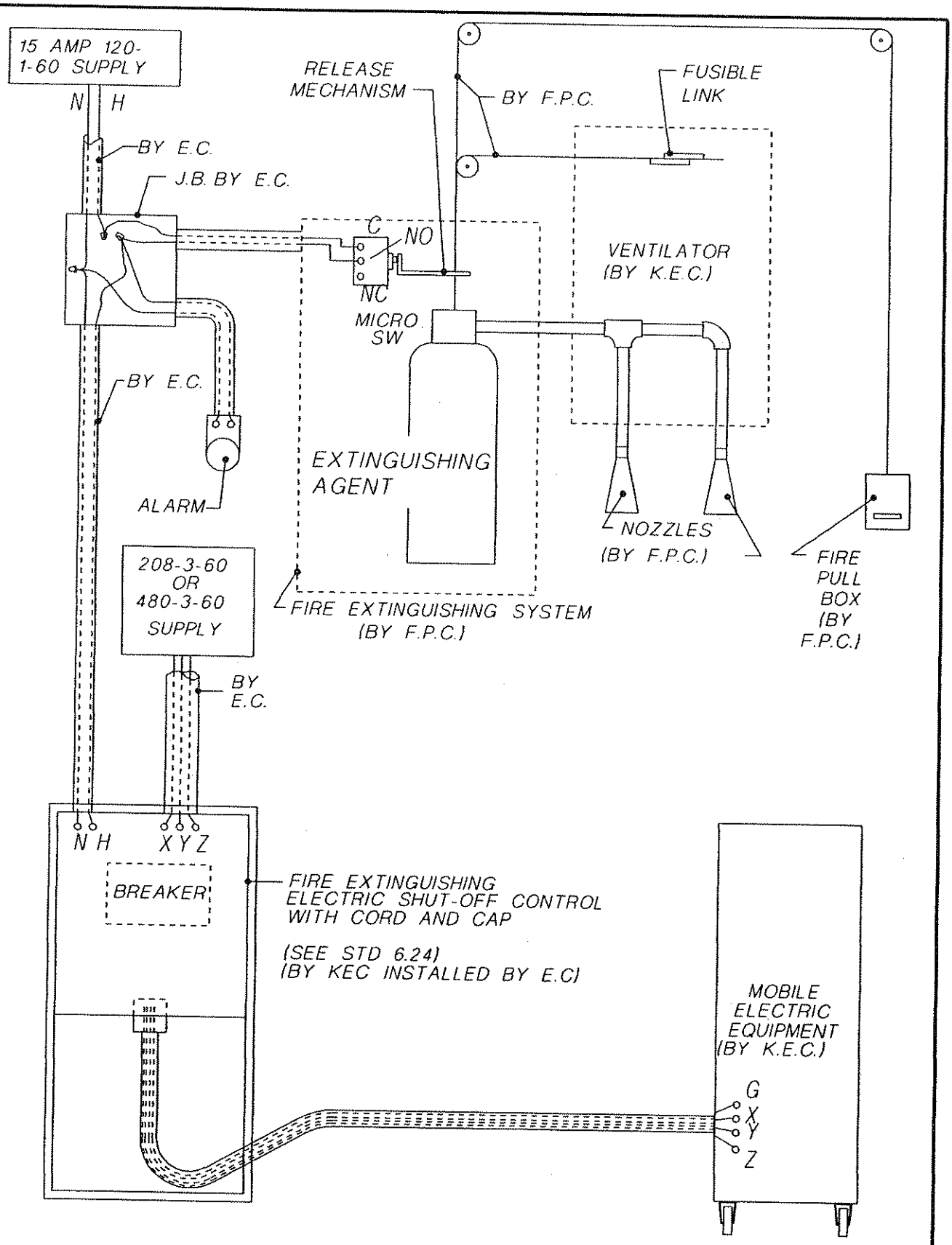
APPROVED: 11-01-02

DISHWASHER VENT DUCT

NO SCALE

STANDARD DETAIL

5.06



APPROVED: 11-01-02

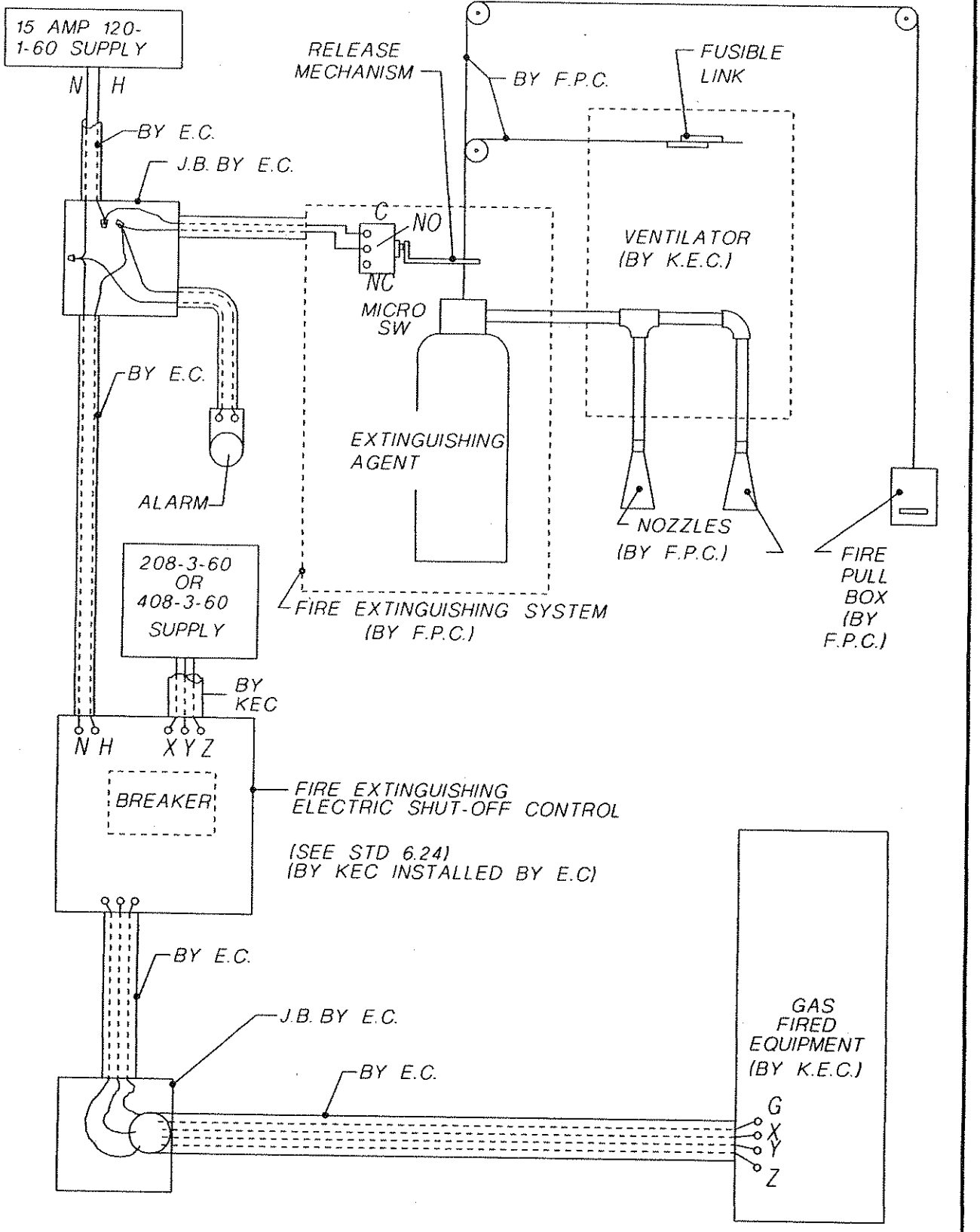
AUTOMATIC FIRE EXTINGUISHING ELECTRIC SHUT-OFF MOBILE EQUIPMENT

NO SCALE

SEE ALSO 6.24

STANDARD DETAIL

6.21



APPROVED: 11-01-02

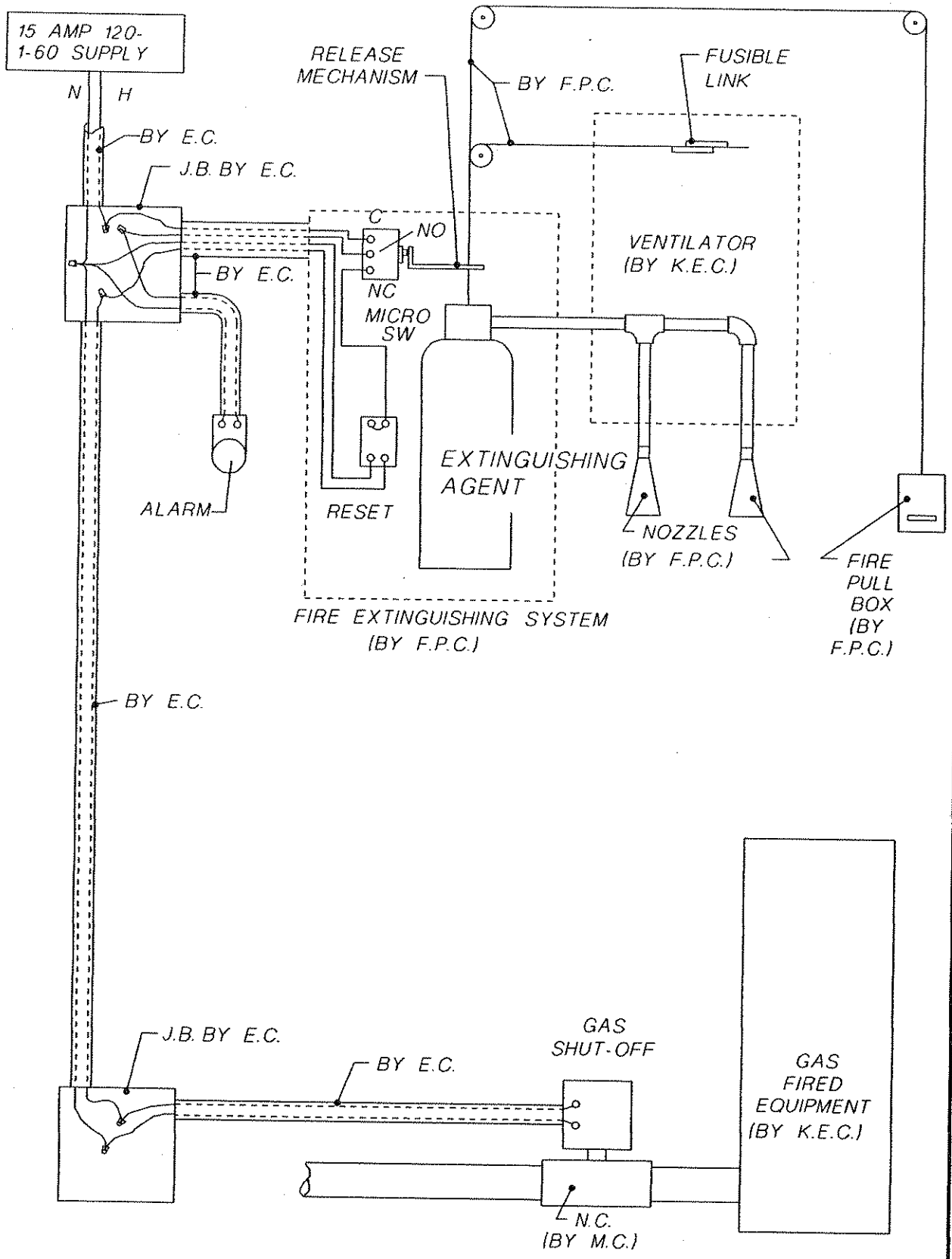
AUTOMATIC FIRE EXTINGUISHING ELECTRIC SHUT-OFF STATIONARY EQUIPMENT

NO SCALE

SEE ALSO 6.24

STANDARD DETAIL

6.22



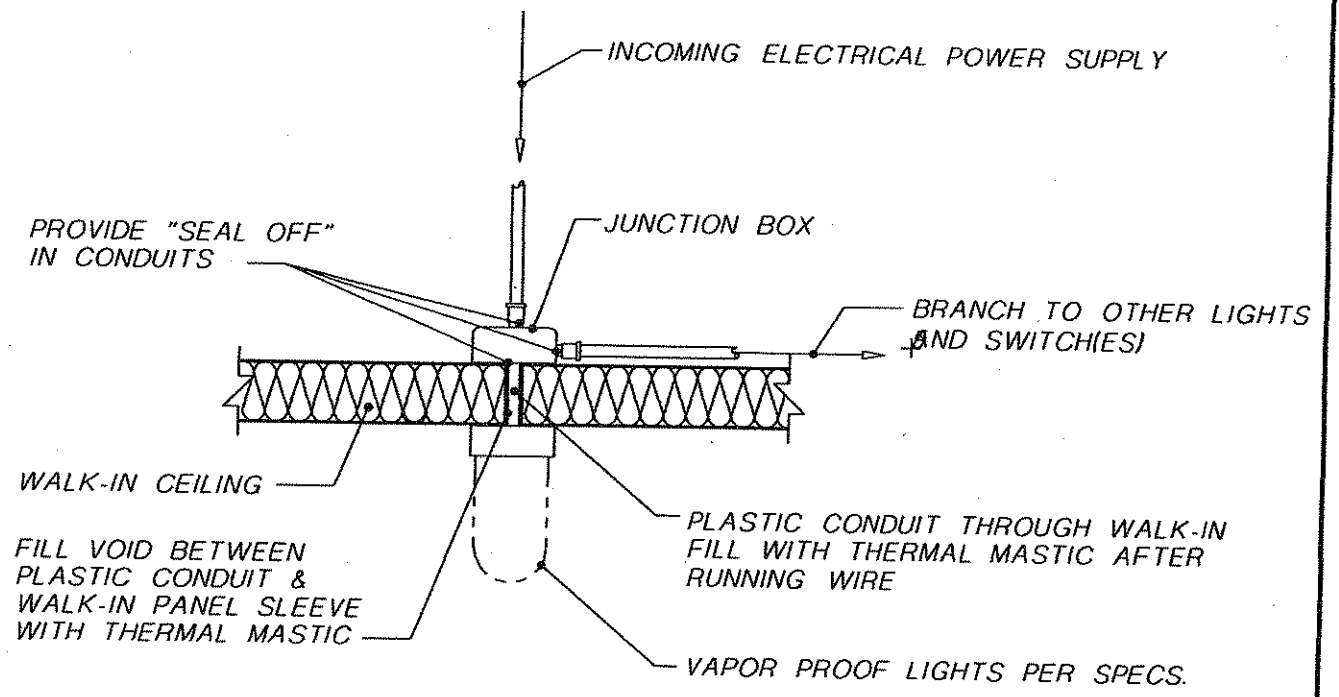
APPROVED: 11-01-02

AUTOMATIC FIRE EXTINGUISHING ELECTRIC SHUT-OFF GAS EQUIPMENT

NO SCALE

STANDARD DETAIL

6.23



1. ALL CONDUIT TO BE RUN ON EXTERIOR OF WALK-IN.
2. ALL PENETRATIONS THRU WALK-IN ARE TO BE SEALED WITH THERMAL MASTIC.
3. LIGHT FIXTURES TO BE SHIPPED LOOSE BY KEC FOR INSTALLATION AT JOB SITE UNDER ELECTRICAL PORTION OF PROJECT

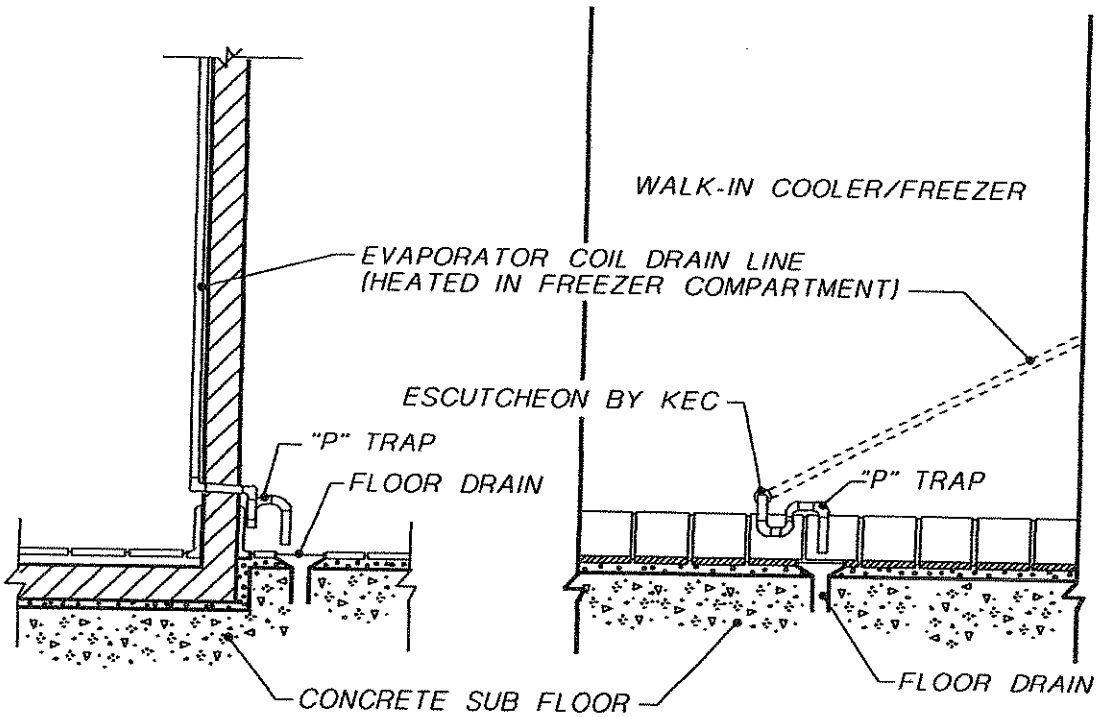
APPROVED: 11-01-02

WALK-IN REFRIGERATOR LIGHT INSTALLATION

NO SCALE

STANDARD DETAIL

7.02

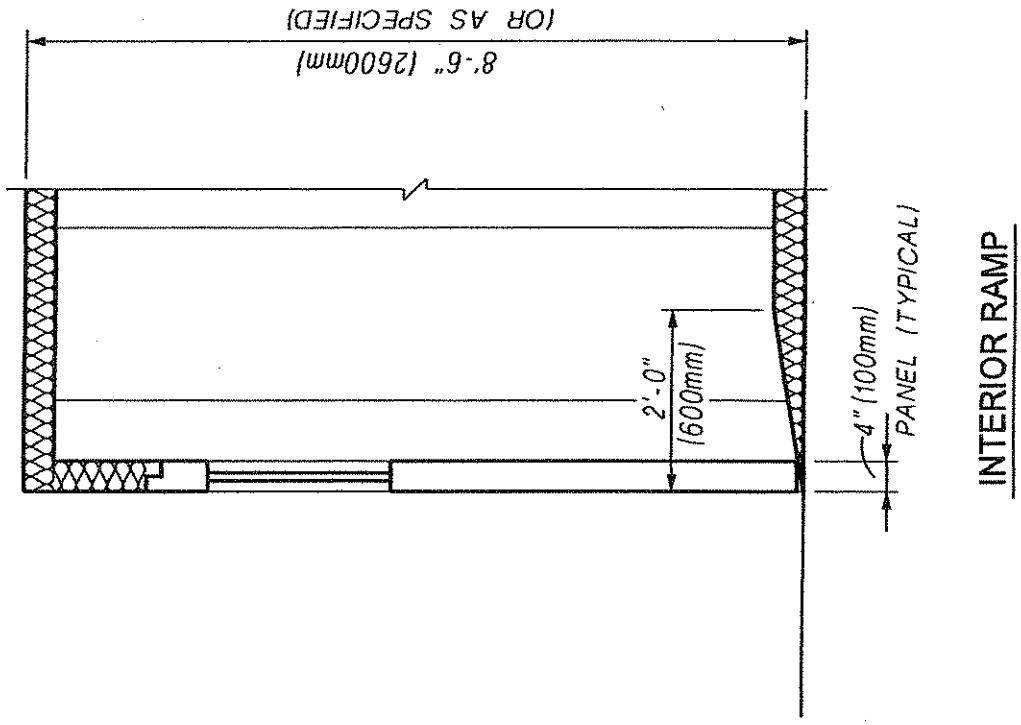


K.E.C. TO PROVIDE AND INSTALL WALK-IN COOLER/FREEZER ASSEMBLY. EVAPORATOR COIL DRAIN LINE AND "P" TRAP AS DETAILED TO BE PROVIDED AND INSTALLED BY THE KITCHEN CONTRACTOR.

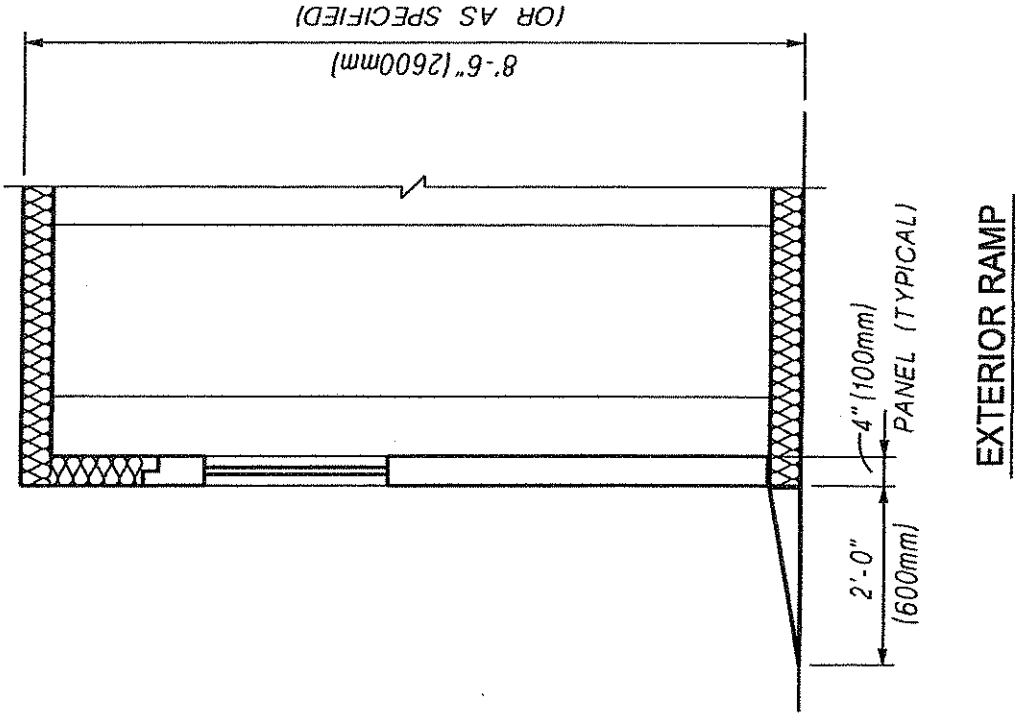
SEAL ALL PENETRATIONS NEATLY WITH THERMAL MASTIC.

APPROVED: 11-01-02

	EVAPORATOR COIL DRAIN "P" TRAP NO SCALE	STANDARD DETAIL 7.03



INTERIOR RAMP



EXTERIOR RAMP

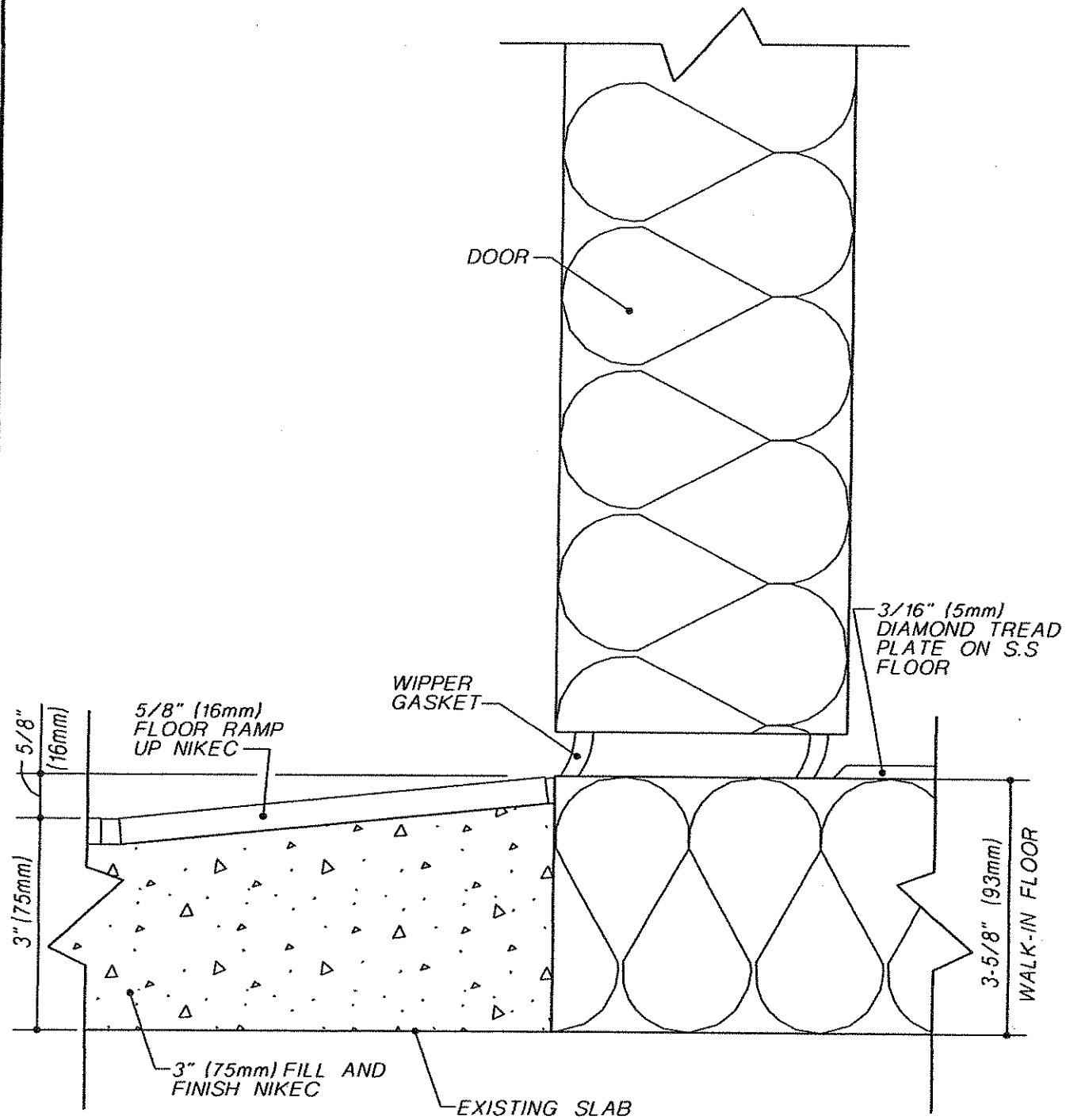
APPROVED: 11-01-02

	WALK-IN REF. / FREEZER RAMP DETAIL NO SCALE	STANDARD DETAIL 7.05

WALK-IN REFRIGERATOR / FREEZER SET IN DEPRESSION

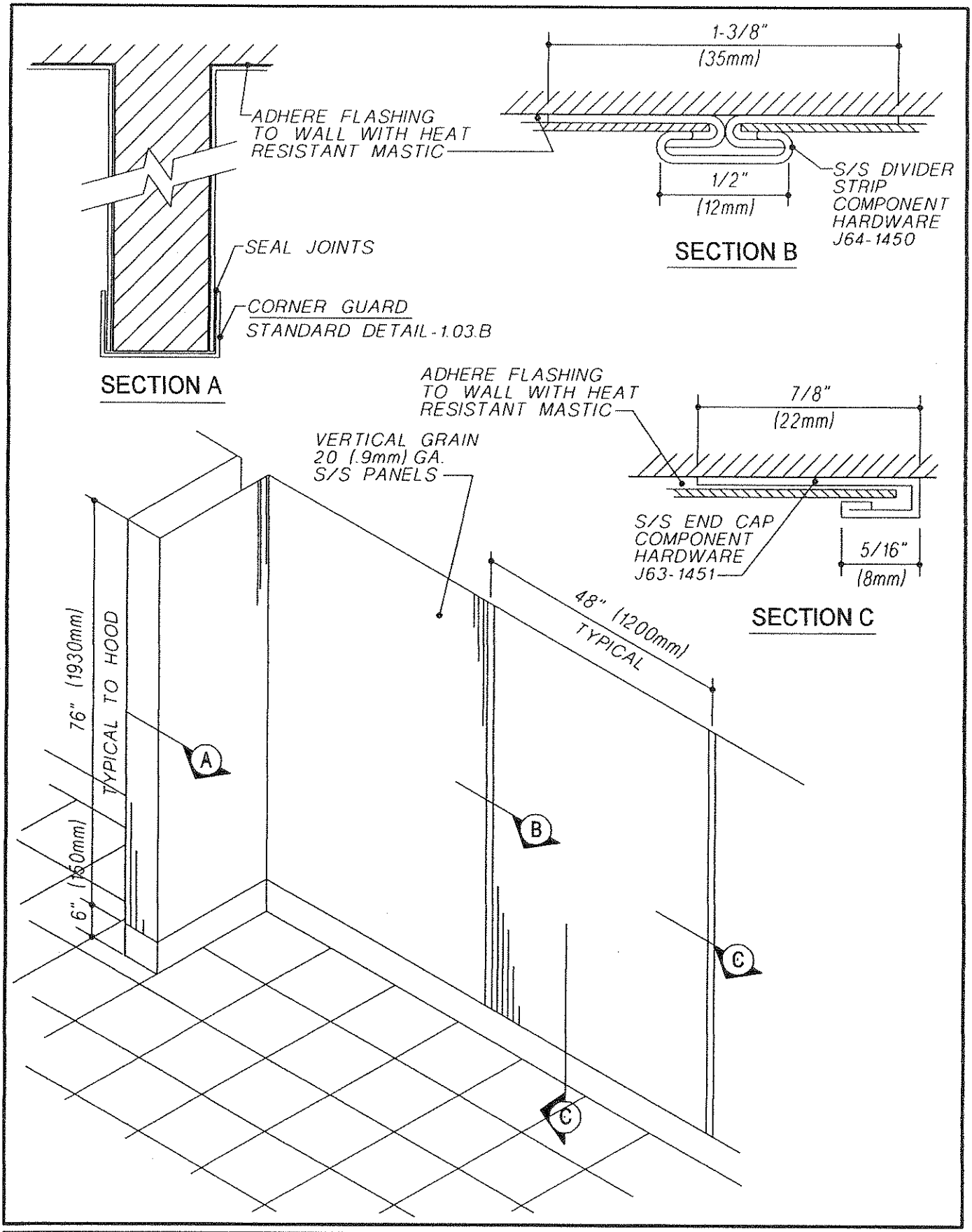
APPROVED: 11-01-02

WALK-IN REF. / FREEZER SET IN DEPRESSION NO SCALE	STANDARD DETAIL 7.06



APPROVED: 11-01-02

	WALK-IN REF. / FREEZER SET IN DEPRESSION NO SCALE	STANDARD DETAIL 7.06.1



APPROVED: 11-01-02

	STAINLESS STEEL WALL SHEATHING NO SCALE	STANDARD DETAIL 8.02

DIVISION 11
EQUIPMENT

SECTION 113100

RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the appliances as shown on the drawings and/or specified herein.

1.3 RELATED SECTIONS

A. Sinks and related plumbing fixtures - Division 22.

B. Electrical - Division 26.

1.4 SUBMITTALS

A. Submit catalog cuts, product information and technical data for each appliance.

1.5 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.6 DELIVERY AND STORAGE

A. Deliver products to project site in manufacturer's undamaged protective containers.

B. Delay delivery until spaces to receive them have been fully enclosed and utility rough-ins are complete.

PART 2 PRODUCTS

2.1 APPLIANCES

A. Refer to appliance schedule on the drawings.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where appliances are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the original design, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Architect, anchoring all components firmly into position for long life under hard use.

C. Upon completion of installation and hookup to utilities, put each operating component of each appliance through at least five (5) complete operating cycles, adjusting as needed to secure optimum operation level.

D. Touch up scratches and abrasions to be completely invisible to the unaided eye from a distance of five (5) feet.

E. Promptly remove from the job site all cartons and packing material associated with the work of this Section.

END OF SECTION

DIVISION 12
FURNISHINGS

SECTION 122216

CURTAIN TRACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the curtain tracks as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Recessed tracks, installation only.

2. Accessories and hardware required for complete installation and operation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include material descriptions, construction details, dimensions of individual components and profiles, features, and finishes.

B. Shop Drawings: Submit floor layout and elevations, indicating location of mechanism details, type and size of each unit, type and location of controls. Submit shop drawings showing details of installation and relation to adjoining construction and conditions.

C. Mock-Up

1. Install each type of curtain track assembly for Architect's acceptance of installation details, workmanship, and operation.

2. Approved mock-up shall be used as the standard for installation of work under this Section, and no further installation work shall proceed before Architect's acceptance of the mock-up.

1.3 WARRANTY

A. Manufacturer's standard non-depreciating 25-year limited warranty covering all hardware.

PART 2 PRODUCTS

2.1 CURTAIN TRACKS

A. Installation only by the Contractor.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where curtain tracks are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION: GENERAL

A. Coordinate with the work of other trades to ensure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the indicated design and the installation recommendations of the manufacturer as approved by the Architect.

C. Upon completion of the installation, put all components through at least ten (10) complete cycles of operation, adjusting as necessary to achieve optimum operation.

3.3 PROTECTION AND CLEANING

A. Protect installed units to ensure proper operating condition, without damage or blemishes. Repair or replace damaged units as directed by the Architect.

END OF SECTION

SECTION 122413

WINDOW SHADES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the window shades as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Manually-operated window shades.
2. Electrically-operated window shades.
3. Field measurements of as-built conditions.
4. Emergency lighting inverter system, Myers Single Phase Modular system. Coordinate with electrical.
5. Accessories and hardware required for complete installation and operation.

1.3 RELATED SECTIONS

A. Electrical - Division 26.

1.4 QUALITY ASSURANCE

A. Provide assemblies which are complete assemblies produced by one manufacturer, including hardware, accessory items, mounting brackets, and fastenings.

B. Provide materials in colors as selected by the Architect from manufacturer's standard colors.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

1. Motorized Shade Operators: Include operating instructions.
2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

B. Shop Drawings: Submit floor layout and elevations, indicating location of all window treatments, mechanism details, type and size of each unit, type and location of controls. Shop drawings must also show seaming of shade fabric. Submit shop drawings showing details of installation and relation to adjoining construction and conditions.

C. Samples: Submit full size sample of each shade type for Architect's acceptance.

D. Mock-Up

1. Install each type of shade assembly on one complete column bay for Architect's acceptance of installation details, workmanship and operation.

2. Approved mock-up shall be used as the standard for installation of work under this Section, and no further installation work shall proceed before Architect's acceptance of the mock-up.

1.6 WARRANTY

A. Manufacturer’s standard non-depreciating 25-year limited warranty covering all hardware, motors, motor control system and shade cloth.

1.7 DELIVERY, STORAGE AND HANDLING

A. Protect shades from damage, soiling and deterioration during transit, storage and handling to, until Owner's acceptance.

PART 2 PRODUCTS

2.1 MANUALLY OPERATED SHADES

A. Provide manually operated shade system equal to "Mechoshade/5 System," made by the Mecho-Shade Corp. or equal made by WT Shade, Sol-R-Veil Inc., Draper, Rollease Acmeda Contract Series 1 or approved equal conforming to standards specified herein.

B. Shade system shall be pre-engineered overrunning clutch design that disengages to 90% during the raising and lowering of the shade. The brake can stand a pull force of 40 lb. in the stop position, or sized as required for shade weight, requiring no adjustment. Self-lubricating hub on to which the brake system is mounted includes an articulated brake assembly which assures smooth, non-jerky operation in raising and lowering the shades. System shall include the following components:

1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing mounting hardware from opening and without requiring end or center supports to be removed.

2. Provide shade hardware that allows for removal and remounting of the shade bands without having to remove the shade tube, drive or operating support brackets.

3. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.

4. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.

5. Provide shade hardware system that allow for operation of multiple shade bands (multi-banded shades) by a single chain operator. Connectors shall be offset to assure alignment from the first to the last shade band.

6. Provide shade hardware constructed of minimum 1/8" thick plated steel or heavier as required to support 150% of the full weight of each shade.

7. Drive Bracket/ Brake Assembly:

   a. MechoShade Drive Bracket M5, WT Shade SoloMount, or equal by other manufacturers noted herein.
   b. Rollease Acmeda chain driven clutch operating system. Drive Chain: #10 qualified stainless steel chain rated to 90 lb.
   c. Minimum Breaking Strength: Nickel plate chain shall not be accepted.

C. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.

1. Hem Pockets and Hem Weights: Fabric hem pocket with RF welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be the same, for all shades within one room.

2. Shade Band and Shade Roller Attachment:

   a. Provide extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without deflection. Provide for positive mechanical engagement with drive/ brake mechanism.
   b. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable/ replaceable with a snap-on/snap-off spline mounting, without having to remove shade roller from shade brackets.
   c. Mounting spline shall not require use of adhesives, adhesive tapes, staples and/or rivets.

2.2 ELECTRICALLY OPERATED SHADES

A. Provide electrically operated shade system equal to "ElectroShade" made by the MechoShade Corp., "Automate" by Rollease Acmeda or equal made by Lutron, Sol-R-Veil Inc. or approved equal conforming to standards specified herein.

1. Integrate with Lutron system in Electrical sections.

B. Access and Material Requirements:

1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.

2. Provide shade hardware that allows for removal and remounting of the shade bands without having to remove the shade tube, drive or operating support brackets.

C. Motorized Shade Hardware and Shade Brackets:

1. Provide shade hardware constructed of minimum 1/8" thick plated steel, or heavier, thicker, as required to support 150% of the full weight of each shade. Plastic components without use of steel angle construction do not meet the intent of this specification and shall not be accepted.

2. Provide shade hardware system that allows for field adjustment of motor or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).

3. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 8-45 degrees from the motor axis between shade bands (4-22.5 degrees) on each side of the radial line, by a single shade motor.

   a. Provide one shade band per window unit up to six shade band units per motor.
   b. All shade bands within a single motor group shall be aligned within ¼".

D. Shade Motors:

1. Intelligent Encoded Motor and Control System: Tubular, asynchronous (non-synchronous) motors, with built-in reversible capacitor operating at 110v AC (60 Hz), or 24-35v DC motor single phase, temperature Class A, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each motor.

2. Conceal motors inside shade roller tube.

3. Maximum current draw for each shade motor of 2.3 amps. Motors shall not exceed 44 dBA measured from 3 feet from the motor.

4. Use motors rated at the same nominal speed for all shades in the same room

E. INTELLIGENT ENCODED ELECTRONIC DRIVE SYSTEM

1. Electronic Drive Unit (EDU):

   a. Intelligent Encoded EDU, and Control System: Tubular, asynchronous (non-synchronous) EDU's, with built-in reversible capacitor operating at 120VAC/60Hz, (230VAC/50Hz) single phase, temperature Class B, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each EDU.
      1). Quiet [42 – 46 db] (within 3 feet open air).
      2). Conceal EDU's inside shade roller tube.
      3). Maximum current draw for each shade EDU of 0.9Amps at 120VAC.
      4). Use EDU's rated at the same nominal speed for all shades in the same room.
      5). Use EDU's with minimum of 34RPM, that shall not vary due to load / lift capacity.
      6). Total hanging weight of shade band shall not exceed 80 percent of the rated lifting capacity of the shade EDU and tube assembly.

F. EDU System: (software, two-way communication): Specifications and design are based on the Intelligent EDU Control System, WhisperShade®IQ® System) as manufactured by MechoSystems. Other systems may be acceptable providing all of the following performance capabilities are provided. EDU and control systems not in complete compliance with these performance criteria shall not be accepted as equal systems.

   1. EDU shall support two methods of control.

      a. Local Dry Contact Control Inputs:

1). EDU shall be equipped with dry contact inputs to support moving the EDU/shade to the upper and lower limits.
2). EDU shall be equipped with dry contact inputs to support moving the EDU/shade to local switch preset positions.
3). Shall support configuring the EDU under protected sequences so that a typical user would not change the EDU's setup. At a minimum the configuration should include setting limits, setting custom presets and configuring key modes of operation.

b. Network Control:
1). EDU shall be equipped with a bi-directional network communication capability in order to support commanding the operation of large groups of shades over a common backbone. The network communication card shall be embedded into the tubular EDU assembly.

2. Upper and lower stopping points (operating limits) of shade bands shall be programmed into EDU's using either a hand held removable program module / configurator or a local switch.

3. Alignment Positions: Each EDU shall support a minimum of 133 repeatable and precisely aligned shade positions (including limits and presets).

a. All shades on the same switch circuit or with the same network group address with the same opening height shall align at each limit or preset (intermediate stopping position) when traveling from any position, up or down.
b. Shades of differing heights shall have capability for custom, aligned intermediate stop positions when traveling from any position, up or down.
c. Alignment of shades mechanically aligned on the same EDU shall not exceed +/- 0.125 inches (3.175mm) when commanded to the same alignment position.
d. Alignment of shades on adjacent EDU's shall not exceed +/- 0.25" inches (6.35mm) when commanded to the same alignment position.
e. Local Switch Presets: A minimum of 3 customizable preset positions shall be accessible over the local dry contact control inputs and over the network connection.
1). Upon setting the limits for the shade EDU these preset positions shall automatically default to 25%, 50% and 57% of the shade travel.
2). These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator or local switch shall be capable of customizing the position of these presets.
f. Network Presets: A minimum of 29 customizable preset positions (including the 3 local switch presets) shall be accessible via network commands.
1). Upon setting the limits for the shade EDU these preset positions shall automatically default to the lower limit unless customized elsewhere.
2). These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator shall be capable of customizing the position of these presets.

4. Network Control:

a. The system shall have the capability of two-way digital communication with the EDU's over a common backbone.
b. Each EDU shall possess 8 addresses capable of being employed for various levels of group control. These addresses shall be configurable via a handheld configurator and/or a PC controller. A 9th unique address shall enable the EDU(s) to be independently controlled and configured over the network via a handheld configurator and/or a PC controller.
   1). Low Voltage Communication Network Implementation.
      (a). The low voltage network shall employ a bus topology with daisy chained network connections between nodes over a CAT5 cable (4 UTP) or over a 2 UTP cable employing at least 1 pair at 16 AWG for power and 1 pair at 22 AWG for data.
      (b). The low voltage network (+/- 13VDC) shall be powered by the nodes attached to it. These nodes could be line voltage powered EDU's attached to 120 VAC or 230 VAC. Alternatively, low voltage nodes shall be powered typically by a centralized low voltage power supply. If a CAT5 network cable is employed and the node draws less than 1W then the node may be powered by DC power supplied by an associated line voltage EDU.
      (c). Network Capacity: 4000 ft max, 250 nodes max
      (d). The number and size of a centralized DC supply shall vary depending upon the network requirements.

5. Operating Modes:

   a. Uniform or Normal Modes of Operation:
      1). Uniform mode shall allow for shades to only move to defined intermediate stop positions to maintain maximum uniformity and organization.
      2). Normal Mode shall allow for shades to move to both intermediate stop positions, plus any position desired between the upper and lower limits as set by the installer.

6. Wall Switches:

   a. Shades shall be operated by, 5, 7, or 10-button low voltage standard switches, or programmable intelligent switches [IS]. Standard switch shall be wired to a bus interface and the bus interface will be programmed to transmit an address for the local switch.
   b. Intelligent switches may be installed anywhere on the bus line. Each IS shall be capable of storing one control level address to be broadcast along the bus line.
   c. An address that is transmitted by either a switch or central controller shall be responded to by those EDU's with the same address in their control table.
   d. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
   e. Standard switch or IS may control an individual, sub-group or group of EDU's in accordance with the address in each EDU.
   f. Clear protective switch lock boxes to be provided b/o in public space as noted on drawings.

G. Shade Band: As described herein for manual shades.

H. Shade Boxes: Provide as detailed on the drawings.

I. Finishes: Unless otherwise noted, all exposed aluminum parts have an anodized finish. Steel parts are either nickel plated, satin finish, or have been bonderized prior to painting with a baked, enamel finish.

J. Side Channels: Provide standard "blackout" side channels where black-out shades are required. Channels shall be extruded aluminum, with a black anodized finish, color selected by the Architect.

2.3 SHADE CLOTH

A. Solar Shade: Shade cloth shall be "Eco-Veil" group, 1350 Series of weave, color and optical properties as selected by the Architect made by MechoShade, Ambient Screen 5% (PVC Free) by Rollease Acmeda Contract or equal by other manufacturers noted herein.

B. Blackout Shades: Shade cloth shall be "Equinox 0100 Series" opaque acrylic blackout shade cloth made by MechoShade, Rollease Acmeda Contract Shade Cloth Sierra Sol Mesa, or equal by other manufacturers noted herein; color selected by the Architect.

2.4 FABRICATION

A. The shade and the fabric shall hang flat without buckling or distortion. The edge, when trimmed, shall hang straight without curling or raveling. An unguided roller shade cloth shall roll true and straight, without tracking sideways more than +/- 1/8" in either direction due to warp distortion or weave design. Shades shall fill window openings from head to sill and jamb to jamb.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where window treatments are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION, GENERAL

A. Coordinate with the work of other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the indicated design and the installation recommendations of the manufacturer as approved by the Architect.

C. Upon completion of the installation, put all components through at least ten (10) complete cycles of operation, adjusting as necessary to achieve optimum operation.

3.3 INSTALLATION OF MANUAL ROLLER SHADES

A. Install roller shades level, plumb, square, and true according to manufacturer’s written instructions and located so shade band is not closer than 2" to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

3.4 INSTALLATION OF MOTOR OPERATED SHADES

A. Install roller shades level, plumb, square, and true according to manufacturer’s written instructions and located so shade band is not closer than 2" to interior face of glass. Allow proper clearances for window operation hardware.

B. To control the responsibility for performance of motorized roller shade systems, the Contractor shall assign the engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and his authorized installer/dealer. The Architect will not produce a set of electrical drawings for the installation of control wiring for the motors, or motor controllers of the motorized roller shades. Power wiring (line voltage or low voltage), shall be provided by the roller shade installer/dealer, in accordance with the requirements provided by the manufacture. Coordinate the following with the roller shade installer/dealer:

1. Contractor shall provide power panels and circuits of sufficient size to accommodate roller shade manufacturer’s requirements, as indicated on the mechanical and electrical drawings.

2. Contractor shall coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.

3. Roller shade installer/dealer shall run line voltage as dedicated home runs (of sufficient quantity, in sufficient capacity as required) terminating in junction boxes in locations designated by roller shade dealer.

4. Roller shade installer/dealer shall provide and run all line voltage (from the terminating points) to the motor controllers, wire all roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/control locations designated by the Architect. All above ceiling and concealed wiring shall be plenum rated, or installed in conduit, as required by the electrical code having jurisdiction.

5. Contractor shall provide conduit with pull wire in all areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule.

C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

E. Engage installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.5 PROTECTION AND CLEANING

A. Protect installed units to ensure proper operating condition, without damage or blemishes. Repair or replace damaged units as directed by the Architect.

END OF SECTION

SECTION 123640

STONE COUNTERTOPS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the stone countertops as shown on the drawings and/or specified herein including, but not limited to, the following:

1. Countertops, backsplashes and fascias for bathrooms.

2. Stone shelves at kitchen.

3. Stainless steel anchoring and fastening devices.

1.3 RELATED SECTIONS

A. Architectural Woodwork - Section 064023.

B. Lavatories - Division 22.

1.4 SUBMITTALS

A. Shop Drawings for Stone: Submit complete cutting and setting drawings to Architect for approval. Show sizes, shapes, thicknesses, jointing, anchoring, connection with other work, typical and special anchoring details, supports, dimensions, setting numbers, and color range for stone. Clearly indicate dimensions for locating cutouts in stone. Do not fabricate any stone countertops (except for samples) until shop drawings have been approved by the Architect.

B. Samples

1. Stone: Submit 3 sets of 12" x 12" samples of stone. Include full range of color and texture to be expected. Architect will review for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

2. Anchoring and Fastening Devices: Submit 3 samples of each type of anchoring and fastening device.

C. Slab Review: After acceptance of Initial Stone Samples, visit by Architect and Owner for review and approval of stone slabs prior to finishing and including some finished slabs and including initial visual mock-up as noted on the drawings.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect stone during storage and construction against wetting, soiling, staining and damage.

B. Handle stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials.

C. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around stones.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stone

1. Stone Quality and Characteristics: All stone shall be of best quality, sound stock, and carefully selected; uniform in color, pattern, markings, texture and finish; and free from defects impairing strength, durability or appearance such as cracks, seams, mineral stains, flaws, or imperfections which are not a normal characteristic of the stone. Patching or filling of chips or cracks is not permitted. Delivered stone shall match the approved samples, and any stone not matching the approved sample may be rejected by the Architect as unfit. Size and thickness of stone units as indicated on drawings.

2. Stone: Stone shall be as scheduled on Materials List on the drawings with polished finish on all exposed surfaces; concealed surface shall be sawn.

3. Backsplashes: Provide 3/4" thick backsplashes of stone matching countertops, height as indicated.

B. Anchors and Fastening Devices: Fabricate from AISI Type 304 stainless steel, No 4 finish.

C. Stone Sealer: Seal stone surfaces with "S-34" made by HMK or approved equal.

PART 3 EXECUTION

3.1 SETTING STONE COUNTERTOPS AND COUNTER FASCIAS

A. Cut-outs and Drilling: Provide countertops with cut-outs for sinks, faucets, etc. Cutouts shall be carefully made in accordance with templates furnished under the Plumbing Section. Stone shall be drilled as required to receive anchoring and fastening devices.

B. Setting: Set countertops in required pattern over cabinet work using stainless steel anchors. Counter fascias shall be doweled to countertop. Set countertops and counter fascias level, plumb and square.

C. Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16" gap between countertop and splashes for filling with sealant. Use temporary shims to ensure uniform spacing.

D. Stone shall be set so that adjacent sections of stone are sequence matched for veining.

E. Joints: Maintain an even joint between units, 1/16" max. Point joints with approved elastic non-staining mastic pointing compound, color to match stone. Tool joints flush. Clean exposed surfaces carefully.

1. All countertops shall be fabricated in one piece and installed with joints at edges only.

3.2 REPAIR, CLEANING AND SEALING

A. Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework. Patching or hiding chips or cracks in stone will not be permitted. Provide new matching units, install as specified and reseal joints to

eliminate evidence of replacement. Reseal defective and unsatisfactory joints to provide a neat, uniform appearance.

B. Clean and seal stonework after completion using sealer specified herein and cleaner as recommended by sealer manufacturer; follow manufacturer's instructions.

3.3 PROTECTION

A. After installation and cleaning, protect stone work from damage during subsequent construction activities.

B. Provide protection for finished work such as exposed edges, corners, and all other stone liable to physical injury or staining. Protection shall include, but is not limited to, non-staining approved coverings.

END OF SECTION

SECTION 129300

SITE FURNISHINGS

PART 1 — GENERAL

1.1 SUMMARY

A. Provide site furnishings and all materials necessary for the installation of site furnishings as indicated on Drawings and as specified herein. Including:
   1. Campus Standard Benches
   2. Campus Standard Bike Racks
   3. Waste Receptacles

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each product used. Provide certifications that materials and systems comply with specified requirements.

B. Installer qualifications: Installer must submit evidence of a successful installation history with comparable materials and designs specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in manufacturer’s original, unopened containers and packaging. Upon delivery, examine packages immediately to ensure all products are complete and undamaged.

B. Store products in a protected, dry area in manufacturer’s unopened containers and packaging.

C. Protect product finish from damage during handling and installation.

1.5 COORDINATION

A. Coordinate with site work and other appropriate sections of the specifications to maintain proper provisions of the work specified.

B. All site furnishings shall be laid out in the field and approved by the Landscape Architect prior to installation.

1.6 WARRANTY

A. Provide manufacturer’s standard warranty for all site furnishings.

PART 2 — PRODUCTS

2.1 GENERAL

A. Provide products and materials of new stock, free from defects and surface blemishes, and of best commercial quality for each intended purpose.

2.2 CAMPUS-STANDARD BENCHES

A. Benches shall be model C-10 Special Bench by Victor Stanley, Inc, Dunkirk, MD, Tel: (800) 368-2573; sales@victorstanley.com; www.victorstanley.com. Size to be six ft length with end armrests.

B. Materials:
1. Ductile iron end frames and a 1-5/16" (33mm) tubular steel rung.
2. Slats: 2" x 3" nominal 2nd Site Systems® reinforced recycled plastic slats; Color: Cherry.

C. Finish: Hot dip galvanize end frames prior to powder coating for additional corrosion resistance. TGIC Polyester Powder Coat (Black).

D. Mounting: Surface Mount per manufacturer's instructions.

2.3 CAMPUS-STANDARD BIKE RACKS

A. Bike racks shall be No Scratch Flattop Inverted U bike rack(s) by Sportworks Northwest, Inc. Rack shall incorporate Santoprene® rubber bumper into design construction to protect bikes. Bumper shall offer a constant service temperature range from -60°C to 135°C (-81°F to 275°F) with no cracking or tackiness.
1. Manufacturer: Sportworks Northwest, Inc., 15540 Woodinville-Redmond Rd NE, Bldg A-200, Woodinville, WA; Tel: (425) 483-700; www.sportworks.com

2. Dimensions: 28" long x 6" wide x 33" tall.

3. Materials: Mild steel
a. Outer tube: 2 x 1 x 0.120 rectangular tubing.
b. Inner bar: 0.25 x 2 flat bar
c. Soft Pad: Santoprene TPV.

4. Finish: Zinc plating pre-coat and TGIC Polyester Powder Coat (Black).

5. Mounting: Embedded Mount per manufacturer's instructions.

2.4 WASTE RECEPTACLES

A. Waste receptacles shall be Universal Receptacle by Forms+Surfaces, 30 Pine Street Pittsburgh, PA 15223; Tel: (800) 451-0410; sales@forms-surfaces.com; www.forms-surfaces.com

B. Dimensions: 24-gallon, side-opening receptacle with standard opening / standard opening lid and split-stream interior.

C. Materials:
1. Body: Stainless Steel.
2. Lid: Polyethylene with UL94HB fire rating.
3. Base: Polyethylene with UL94HB fire rating OR TENSL ultra high performance concrete.
4. Liners: Black polyethylene with UL94HV fire rating.
5. Hardware: Stainless steel.

D. Finishes:
1. Body: Satin.
2. Lid: Slate-colored lightly textured finish.

3. Base: Slate-colored lightly textured finish.
4. Body Patterns: none

E. Instructional Graphics:
1. Apply instructional back-printed polycarbonate graphics to lids as specified to indicate the intended waste or recycling stream. Confirm content of instructional graphics with Client or Owner's Representative prior to ordering.
2. Letters and symbols color: White.
3. Graphics background colors: 1) Black. 2) Blue. 3) Green; confirm with Client or Owner's representative.

F. Mounting: Free standing (provide levelers).

PART 3 — EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Install in conformance to applicable ADA Guidelines and End User's established Accessibility policies.

END OF SECTION 129300

DIVISION 13
SPECIAL CONSTRUCTION

SECTION 123661

ENGINEERED QUARTZ COUNTERTOPS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the engineered quartz countertops as shown on the drawings and/or specified herein including, but not limited to, the following:

1. Quartz-based fabricated stone countertops.

2. Simulated stone countertops fabricated of recycled quartz.

3. Stainless steel anchoring and fastening devices.

1.3 RELATED SECTIONS

A. Architectural Woodwork - Section 064023.

B. Plumbing - Division 22, for lavatories.

1.4 QUALITY ASSURANCE

A. Fire Test Response Characteristics: Provide with the following Class A (Class I) surface burning characteristics as determined by testing identical products per UL 723 (ASTM E 84) or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame Spread Index: 25 or less.

2. Smoke Developed Index: 450 or less.

1.5 SUBMITTALS

A. Shop Drawings For Engineered Stone: Submit complete cutting and setting drawings to the Architect for approval. Show sizes, shapes, thicknesses, jointing, anchoring, connection with other work, typical and special anchoring details, supports, dimensions, setting numbers, and color range for stone. Clearly indicate dimensions for locating cutouts in stone. Do not fabricate any stone tops (except for samples) until shop drawings have been approved by the Architect.

B. Samples

1. Stone: Submit 3 sets of 12" x 12" samples of engineered stone. Include full range of color and texture to be expected. Architect will review for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

2. Anchoring and Fastening Devices: Submit 3 samples of each type of anchoring and fastening device.

C. Product Data

1. Stone: Submit manufacturer's product data, fabrication and installation instructions.

2. Accessories: Submit manufacturer's product data and installation instructions.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect stone during storage and construction against wetting, soiling, staining and damage.

B. Handle stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials.

C. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around stones.

PART 2 PRODUCTS

2.1 QUARTZ STONE

A. Provide 1-1/4" thick quartz stone surfacing as manufactured by CaesarStone Quartz Surfacing or approved equal.

1. Color: See Finish Schedule

2. Finish: Polished on all exposed surfaces unless otherwise indicated.

B. Exposed Edges and Corners:

1. Countertops:

a. Edges: Square. Miter joint with 1/8" diameter eased edge profile at countertop fascia.
b. Outside Corners: Square.

2.2 SIMULATED STONE

A. Simulated Stone Countertops: Provide "IceStone" recycled quartz countertops by DuPont, or approved equal.

1. Size and Configuration: As shown on drawings.

2. Colors: As indicated on the Materials List on the drawings.

3. Anchors and Fastening Devices: Fabricate from AISI Type 304 stainless steel, No 4 finish.

4. Sealer: Seal simulated stone surfaces with manufacturer's approved sealer.

B. Backsplashes: Provide 3/4" thick backsplashes of simulated stone material matching countertops, height as indicated.

2.3 ACCESSORIES

A. Mounting Adhesives: Provide structural-grade silicone or epoxy adhesives of type recommended by manufacturer for application and conditions of use.

1. Acceptable Silicone Manufacturers:

    a. Dow Corning.
    b. GE Sealants and Adhesives.

2. Acceptable Epoxy Manufacturers:

    a. Akemi North America.
    b. Bonstone Material Corporation.
    c. Tenax USA.

3. Provide spacers, if required, of type recommended by adhesive manufacturer.

4. Color: Adhesive or sealant which will be visible in finished work shall be tinted to match quartz surfacing.

B. Fasteners: Type 304, stainless steel meeting ASTM A 666.

C. Joint Sealants: Provide anti-bacterial type.

1. Acceptable Manufacturers:

    a. Dow Corning.
    b. GE Sealants and Adhesives.

D. Solvent: Product recommended by adhesive manufacturer to clean surface of quartz surfacing to assure adhesion of adhesives and sealants.

E. Cleaning Agents: Non-abrasive, soft-scrub type kitchen cleansers.

F. Polishing compound and polishing pads.

2.4 FABRICATION

A. Fabricator: Firm shall have five years' experience fabricating simulated stone and shall have water-cooled cutting tools.

B. Shop Assembly: Observe proper safety procedures and comply with manufacturer's instructions.

C. Layout: Layout joints to minimize joints and to avoid L-shaped pieces of quartz surfacing.

D. Inspection: Inspect material for defects prior to fabrication.

1. Color Match: Materials throughout Project shall be from the same batch and shall bear labels with same batch number. Visually inspect materials to be used for adjacent pieces to assure acceptable color match. Inspect in lighting conditions similar to those on Project.

2. Variation in distribution of aggregates in quartz surfacing which are within manufacturer’s tolerances is not a defect.

E. Tools: Cut and polish with water-cooled power tools.

F. Cutouts

1. Cutouts shall have 3/8" minimum inside corner radius. Inside corners shall be reinforced in an acceptable manner to prevent cracking.

2. Exposed edges of cutout shall be polished.

3. If the remaining material outside a cutout is less than three inches wide, reinforce area by laminating it with a strip of stone.

PART 3 EXECUTION

3.1 SETTING STONE COUNTERTOPS AND COUNTER FASCIAS

A. Cut-outs and Drilling: Provide countertops with cut-outs for sinks, faucets, etc. Cut-outs shall be carefully made in accordance with templates furnished under the Plumbing Section. Stone shall be drilled as required to receive anchoring and fastening devices.

B. Setting: Set countertops in required pattern over steel supports using stainless steel anchors and mounting adhesive. Set countertops level, plumb and square.

C. Stone shall be set so that adjacent sections of stone are sequence matched for veining.

D. Joints: Maintain an even joint between units, 1/16" max. Point joints with approved elastic non-staining mastic pointing compound, color to match stone. Tool joints flush. Clean exposed surfaces carefully. Use polishing compound and polishing pads for a seamless transition at joints in countertop sections.

3.2 REPAIR, CLEANING AND SEALING

A. Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework. Patching or hiding chips or cracks in stone will not be permitted. Provide new matching units, install as specified and reseal joints to eliminate evidence of replacement. Reseal defective and unsatisfactory joints to provide a neat, uniform appearance.

B. Clean stonework after completion using cleaning agent specified herein and as recommended by stone manufacturer; follow manufacturer’s instructions.

3.3 PROTECTION

A. After installation and cleaning, protect stone work from damage during subsequent construction activities.

B. Provide protection for finished work such as exposed edges, corners, and all other stone liable to physical injury or staining. Protection shall include, but is not limited to, non-staining approved coverings.

END OF SECTION

SECTION 124813

ENTRANCE FLOOR MATS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the floor mats as shown on the drawings and specified herein.

1. Sisal mat at entry vestibule.

1.3 QUALITY ASSURANCE

A. Manufacturer: Except as otherwise indicated, provide entrance mats and accessories by a single manufacturer for entire project.

1.4 SUBMITTALS

A. Product Data: Submit manufacture's specifications and installation instructions or entrance mat. Include methods of installation for each type of substrate.

B. Samples: Submit samples for each type and color of exposed entrance mat and accessory required. Provide 12" square samples of mat.

C. Maintenance Data: Submit manufacturer's printed instructions for cleaning, drying, maintaining and rehandling of removable entrance mat units.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 - PRODUCTS

2.1 MAT ASSEMBLY

A. Provide 1" thick sisal carpet mat in one piece, of type and color scheduled on the Materials List on drawings. Mats shall meet DOC Flammability Spec. (DOC-1-FF1-70) and shall not generate static electricity. Mats shall be natural fibers fused into a vinyl backing, classified as a "B" rating under Test ASTM E 84.

B. Adhesive: As recommended by manufacturer of floor mats.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where floor mats are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Protection: Provide temporary filler of plywood or fiberboard in mat recesses. Maintain protection until construction traffic has ended and project reaches substantial completion.

B. Delay installation of mats until work on the project reaches substantial completion.

END OF SECTION

SECTION 131000

ACOUSTICAL SPECIALTIES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the acoustical specialties work as specified herein, including but not limited to, the following:

1. Fire-rated acoustic backer pad.

2. Resilient sound isolation clips.

3. Floating floor panel system.

4. Sound control tile underlayment.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

1.4 SUBMITTALS

A. Material list of items proposed to be provided under this Section.

B. Manufacturer’s specifications and other data needed to provide compliance with the specified requirements.

C. Shop Drawings: Provide in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.

D. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

E. Submittal of other requirements as noted in the body of these specifications.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the installed work and material of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.1 MATERIALS

A. Acoustic Backer Pad, Fire Rated: Kinetics Noise Control; Model Isobacker.

1. Back-to-back junction boxes are to be avoided. Junction boxes shall be offset and placed at least one stud bay or 16-inches apart. Where this is not feasible, junction boxes are to be backed with product indicated above or approved equal.

B. Resilient Sound Isolation Clips: "IsoMax" sound-isolation clips as manufactured by Kinetics Noise Control or approved equal.

1. Vertical Load Capacity: Clips shall have sufficient capacity to support wall or ceiling weights as constructed. In a vertical load test comparable to a ceiling installation, the clip shall have a minimum design load capacity of 36 lbs. using 25 gauge furring channel. The minimum design load capacity when using 22 gauge furring channel shall be 48 lbs. Design Load capacity shall be based on a safety factor where the load to failure, defined as pullout of the channel from the clip, is a minimum 2.5 times the allowable maximum Design Load. Anchors for attachment of the clips to the substructure shall be selected to support wall and/or ceiling weights at each clip.

2. The isolation clips shall consist of a rubber element into which a standard galvanized steel furring channel, 7/8 in. x minimum 25 gauge, is captured. The channel legs snap fit into the rubber element without any metal-to-metal or other rigid contact with building elements.

3. The isolation clip is attached to the wall/ceiling framing or other structural substrate through galvanized steel brackets on each side of the rubber isolation element. The brackets shall be of sufficient strength to carry the wall or ceiling weight without bending or failure.

C. Fitness Floor: Pliteq GenieMat FIT Fitness Flooring, FF70LDM Floating Floor System, TMIP Treadmill Isolation Pads.

1. Material: Pre-engineered OSB (oriented strand board) subfloor panels with elastomer and mineral wool insulation

a. Dimension: 23-1/4" wide x 23-1/4" long panel.
b. Thickness: 2-3/4".
c. Laboratory Impact Insulation Class, ASTM E492: Tested in a NVLAP-certified laboratory and complying with ASTM standards.
d. Field Impact Insulation Class, ASTM E10007: Floor-ceiling assembly shall meet requirements as stated by building code and acoustical consultant.

2. To correctly decouple the isolated floor from the structure, there must be a gap between the edges of the isolated floor and the walls of the fitness area. This can be accomplished with a perimeter isolation board, such as the GenieMat PMI12, by Pliteq Inc. Any columns that extend from the structural slab to the deck above that penetrate the isolated floor must also be framed around with a perimeter isolation board.

3. Treadmill Isolation Pads: GenieMat TMIP Treadmill Isolation Pads by Pliteq.

a. Thickness: 2".
b. Front Pad: 5" x 18".
c. Rear Pad: 5" x 7".

4. Provide two front pads and two rear pads per treadmill.

D. Sound Control Tile Underlayment: Geniemat RST15, 15 mm thick, recycled rubber underlayment as manufactured by Pliteq, Inc.; rebounded, recycled rubber sound control underlayment, made from 94% recycled rubber content.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where acoustical specialties are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, and the manufacturer's recommended installation procedures as approved by the Architect, anchoring all components firmly into position for long life under hard use.

END OF SECTION

DIVISION 14
CONVEYING EQUIPMENT

SECTION 142100

TRACTION ELEVATORS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the traction elevators as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Two (2) machine roomless, gearless traction passenger elevators.

2. One (1) machine roomless, gearless traction back-of-house (service) elevator.

1.3 RELATED SECTIONS

A. Hoistway, pits, supports for buffers - Section 033000.

B. Access doors, pit and buffer ladders - Section 055000.

C. Ventilation for hoistways - Division 23.

D. Electrical - Division 26.

1.4 QUALITY ASSURANCE

A. Elevator Code: Except for more stringent requirements as indicated or imposed by governing regulations (which must be complied with), comply with applicable requirements of the "American Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks," (ANSI A17.1), published by The American Society of Mechanical Engineers, hereinafter referred to as the "Code." Comply with New York State Handicapped Code requirements.

B. Electrical Code: For electrical work included in the elevator work, comply with the "National Electrical Code" (ANSI C1) by NFPA.

C. Elevator Manufacturer: Elevator manufacturer shall make all major apparatus such as machines, motor-generators, controllers, power units, cylinders, etc.

D. Fire Resistance: Except as otherwise indicated, comply with NFPA Standard No. 80 for construction and installation of hoistway entrance. Provide each door unit bearing UL label of approval ("B" label, except as otherwise indicated) as a "Fire Door" if horizontal sliding or vertical bi-parting, and as a "Frame and Fire Door Assembly" if swinging. Where required by NFPA Standard No. 80, provide separate UL labels of approval on hardware, sills, closers and other accessory items of hoistway entrance.

E. Laboratory Testing: Comply with Code for laboratory testing of elevator component parts, including buffers, interlocks, door contacts, wire rope, connectors, fasteners, and other materials and products used in the elevator work. Label such products and materials to indicate the testing and certification by the laboratory.

1.5 SUBMITTALS

A. Manufacturer's Data: For information only, submit the manufacturer's specifications and installation instructions for the complete elevator system, and for each component or product used in the system. Include certified laboratory test reports on components as specified or required by Code. Include a complete listing and description of performance and operating characteristics. Include maximum and average power demands and requirements for temporary power. Include complete description of operation systems, documenting fulfillment of the requirements.

B. Shop Drawings: Submit shop drawings for the elevator system and its components, including typical details of assembly, erection and anchorage drawn at large scale. Show maximum dynamic and static loads imposed on the building structure at points of support for the elevator work. Submit smaller scale drawings of the overall plans, elevations and sections to show the floors served, travel distances and similar considerations of the work. Include wiring diagrams for the entire system of power distribution, lighting, controls, signals, communication, cab finishes, etc. Assemble shop drawings into one coordinated submittal.

C. Samples: For exposed finishes.

D. Maintenance Manuals: Submit 3 copies of bound maintenance and operating instructions, parts lists, recommended spare parts and emergency parts inventory, sources of purchase and similar information. Content of manual must be acceptable to firm selected by Owner to perform continuing maintenance.

1. Provide diagnostic unit to Owner with Operating and Maintenance Manuals at completion of project.

1.6 PERMITS AND INSPECTIONS

A. Obtain and pay for all necessary municipal and State inspections and permits and make such tests as are required by the regulations of such authorities. These tests shall be made in the presence of the authorized representatives of such authorities.

1.7 TESTS

A. When installation is fully completed, the elevator manufacturer shall demonstrate to the entire satisfaction of the Architect and the Owner the proper operation of every part of the equipment and compliances thereof with contract requirements and with all applicable requirements of the ANSI Code. The inspection procedure outlined in the American Standard Practice for the Inspection of Elevators, Inspectors, Manual A17.2, shall form a part of the final inspection.

1.8 MAINTENANCE

A. The elevator manufacturer shall furnish maintenance on each piece of elevator equipment for a period of twelve (12) months after its acceptance. This maintenance shall include examination, adjustment and lubrication of all elevator equipment. The elevator manufacturer shall also repair or replace electrical and mechanical parts produced by the manufacturer of the equipment concerned.

B. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to Owner, in the form of a standard two-year period or other period maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 PRODUCTS

2.1 ELEVATOR CHARACTERISTICS

A. Elevator Manufacturer: Elevator manufacturer shall make all major apparatus such as machines, motor-generators, controllers, power units, cylinders, etc. Elevators shall be equal to "Gen2 Seismic" as manufactured by Otis Elevator; no substitutions.

B. Equipment Description: Gen2 gearless traction elevator with machine-roomless application.

C. Equipment Control: Elevonic Control System.

D. Drive: Regenerative.

E. Stops:

1. Elevator 1: 3.

2. Elevator 2 and 3: 2.

F. Openings:

1. Elevator 1: 3 front.

2. Elevator 2 and 3: 2 front.

G. Travel

1. Elevator 1: 25'-0".

2. Elevator 2 and 3: 14'-0".

H. Rated Capacity: 2,500 lbs. (passenger); 10,000 (service).

I. Rated Speed: 150 fpm.

J. Clear Hoistway:

1. Elevator 1: 8'-8" x 5’-9”.

2. Elevator 2 and 3: 8'-8" x 5'-9".

K. Clear Opening Width: 3'-6".

L. Entrance Type: Single speed, side sliding.

M. Main Power Supply: Refer to Division 26.

N. Car Lighting Power Supply: 120 Volts, Single-phase, 15 Amp, 60 Hz.

O. Signal Fixtures: Manufacturer’s standard with metal button targets (exc. CA).

P. Controller Location: Machine-Roomless Controller(s) shall be located at the front opening of the top terminal landing in the entrance frame.

Q. Freight Elevator: Class 3 loading.

2.2 HOISTWAY EQUIPMENT

A. Platform: Fabricated frame of formed or structural steel shapes, gusseted and rigidly welded with a wood sub-floor. Underside of the platform shall be fireproofed. The car platform shall be designed and fabricated to support one-piece loads weighing up to 25% of the rated capacity.

B. Sling: Steel stiles bolted or welded to a steel crosshead and bolstered with bracing members to remove strain from the car enclosure.

C. Guide Rails: Lubricated steel, fastened to the building with steel brackets.

D. Guides: Slide guides.

E. Deflector Sheaves: Optamid, yellow cast polyamide material, pressed roller bearings, with removable steel shafts.

F. Buffers: Provide substantial buffers in the elevator pit. Mount buffers on pit template fastened to the elevator guide rail or securely anchored to the pit floor. Provide extensions if required by project conditions.

G. Machine: The hoisting machine shall be a compact energy efficient permanent magnet gearless traction type, consisting of permanent magnet AC motor, brake and driving sheave mounted on counterweight rails and main guide rails located at the top of elevator hoistway.

H. Drive System

1. The drive system shall be of the Variable Voltage Variable Frequency (VVVF) Non Regenerative.

2. The system shall be a vector-controlled pulse-width modulated AC drive. The variable voltage variable frequency drive shall convert the AC power supply using a two-step process to a variable voltage variable frequency power supply for use by the hoist motor.

3. The speed control shall be by means of vector control providing direct torque current and field excitation is automatically provided by permanent magnet. A digital absolute velocity encoder shall be provided giving feedback to the controller on armature position and motor speed

I. Motor/Machine: The motor shall be permanent magnet AC, totally enclosed, non-ventilated with class "F" insulation. The motor rotor assembly shall be dynamically balanced and supported by roller bearings of ample capacity. The rotor assembly and driving sheave shall be properly balanced for smooth elevator performance. The machine shall be mounted above the top landing at the top of the hoistway resting on two counterweight rails and main guide rails provided by elevator contractor.

J. Brake: The brake shall be a spring applied electric brake; held open by an electro-magnet actuated by a digital brake controller and designed to make smooth, positive stops. The brake shall be designed to automatically apply in the event of interruption of power supply from any cause. Operation and control of the brake shall be all digital. The setting and lifting of the brake shall be software based and all electronic. All adjustments and setup of the brake shall be made using a PC interface. No contactors or resistors shall be used in the actuation of the brake.

K. Ropes: Provide Steel hoist cables of size and number to ensure proper wear qualities shall be used. Special wedge shackles shall be used.

L. Governor ropes shall be of iron construction.

M. Any special tools, devices, software or equipment required for monitoring the wear of any means of suspension other than standard elevator steel cables shall be included with the installation of the

equipment and become the property of the owner at time of elevator completion. This includes special on-going monitoring systems, special tools and instruction needed to monitor the suspension system.

N. Counterweight: Counterbalance each elevator for smooth and economical operation by using iron or steel plate weights securely fastened in a steel counterweight frame. Counterweight shall equal the weight of the complete elevator car and approximately 45-50 percent of the specified capacity load.

O. Safety and Governor: Car safety shall be mounted on the bottom members of the car frame and be operated by a centrifugal speed governor. The governor shall be designed to cut off power to the motor and apply the brake whenever the governor indicates the car has excessive speed. The governor shall function when the car over speeds.

P. Emergency Terminal Limits: Place electric limit switches in the hoistway near the terminal landings. Limit switches shall be designed to cut off the electric current and stop the car if it runs beyond either terminal landing.

Q. Automatic Self-Leveling: Provide each elevator car with a self-leveling feature to automatically bring the car to the floor landings and correct for over travel or under travel. Self-leveling shall, within its zone, be automatic and independent of the operating device. The car shall be maintained approximately level with the landing irrespective of its load.

2.3 HOISTWAY ENTRANCES

A. Frames: Entrance frames shall be of bolted construction for complete one-piece unit assembly. All frames shall be securely fastened to fixing angles mounted in the hoistway and shall be of UL fire rated steel.

B. Sills shall be extruded nickel silver.

C. Doors: Entrance doors shall be of hollow metal construction with vertical internal channel reinforcements.

D. Fire Rating: Entrance and doors shall be UL fire rated for 1-1/2 hour.

E. Entrance Finish: Stainless Steel.

2.4 CAR ENCLOSURE (PASSENGER ELEVATORS)

A. Materials and Finishes

1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8" nominal thickness.

2. Floor Finish: By others.

3. Wood Paneling: As scheduled on the drawings.

4. Mirrors: Conforming to requirements of Section 088000.

5. Fabricate car with recesses and cutouts for signal equipment.

6. Ceiling: LED perimeter light in stainless steel.

B. Car Front Finish: Satin stainless steel.

C. Car Door Finish: Satin stainless steel.

D. Handrail: Satin bronze, "Vault" handrail.

E. Threshold: Extruded aluminum, with grooved surface, 1/4" thick.

2.5 CAR ENCLOSURE (SERVICE/ FREIGHT ELEVATOR)

A. Materials and Finishes

1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8" nominal thickness.

2. Floor Finish: By others.

3. Car Shell: Constructed of 16 gauge minimum stainless ridged sheet steel panels from floor to canopy with adequate reinforcement to prevent sagging and deflection.

4. Fabricate car with recesses and cutouts for signal equipment.

5. Lighting: Provide four (4) LED light fixtures. Flush mount fixtures in the ceiling and provide 1/8" thick acrylic lenses with stainless steel frame.

B. Car Front Finish: Satin stainless steel.

C. Car Door Finish: Satin stainless steel.

D. Handrail: As selected by the Architect.

E. Threshold: Extruded aluminum, with grooved surface, 1/4" thick.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the elevator with skilled workmen in strict accordance with the accepted shop drawings and other submittals.

B. Comply with the code, manufacturer's instructions and recommendations.

C. Coordinate work with the work of other trades for proper time and sequence to avoid construction delays and to insure right-of-way of system. Use lines and levels to ensure dimensional coordination of the work.

D. Accurately and rigidly secure supporting elements within the shaftways to the encountered construction, within the tolerances established.

E. Provide and install motors, switches, controls, safety and maintenance, operating devices in strict accordance with the submitted wiring diagrams and applicable codes and regulations having jurisdiction.

F. After installation touch up in the field surfaces of shop primed elements which have become scratched or damaged.

G. Lubricate operating parts of system as recommended by the manufacturer.

3.2 PROTECTION AND CLEANING

A. During shipment and installation, adequately protect surfaces against accumulation of paint, mortar, mastic and disfiguration or discoloration, and damage.

B. Upon completion, remove protection and thoroughly clean work and have it free from discoloration, scratches, dents and other surface defects.

C. The finished installation shall be free of defects. Before final completion and acceptance of the building, repair and/or replace defective work, to the satisfaction of the Architect and the Owner at no additional cost.

3.3 DEMONSTRATION

A. Instruct Owner in proper use, operations, and maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of operational failure and other emergencies. Instruct Owner in procedures to follow in identifying sources of operational failures or malfunctions. Confer with Owner on requirements for a complete elevator maintenance program.

B. Make a final check of each elevator operation with Owner present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

END OF SECTION

SECTION 149133

LINEN CHUTE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment and services necessary to install the linen chute, as shown on the drawings, specified herein, and/or as needed for a complete and proper installation.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

B. Plumbing connections - Division 22.

1.4 QUALITY ASSURANCE

A. For actual installation of the chutes, use only personnel who are thoroughly familiar with the manufacturer's recommended methods of installation and who are completely trained in the required skills.

1.5 SUBMITTALS

A. Provide product data, including manufacturer's product specifications, standard details, installation instructions and general recommendations for total pre-engineered chute systems. Mark-up data sheets to indicate actual selections for sizes and other details of installation.

B. Provide shop drawings consisting of 1/4" scale section/elevation drawing, 1/2" scale typical landing plans, and 1-1/2" scale details of each chute fabrication and installation including counter flashing at roof. Distinguish between factory fabrication and field assembly work. Show required piping connections for sprinklers and sanitizers.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Valiant Products.

2. U.S. Chutes Corp.; Brookfield, CT.

3. Wilkinson Chutes, Inc.; Stow, OH.

2.2 MATERIALS AND FABRICATION

A. General: Provide manufacturer's standard chute system of type, service, sizes and shapes (including off-sets) indicated. Fabricate of metals and finishes as indicated; and include support units, expansion joint materials, factory-applied sound deadening material, special intake chute throat sections located where indicated to accommodate door units as specified, discharge door units of type indicated; roof-termination assembly is indicated; include sanitizing or flushing units as specified, sprinkler heads where indicated, and manufacturer's standard accessories, fasteners and installation materials.

B. Chute Metal: Aluminum-coated cold-rolled commercial quality, steel sheet ASTM A463, Type I with T1-40 coating, gage as indicated:

1. Gauge: U.S. No. 16 (0.062-inch thick).

2. Size: 24" dia.

C. Chute Intake Door/Frame Units: Provide self-closing units at each landing, at standard heights above floor. Provide 21" x 21" side hinged doors for laundry chutes, door sizes as indicated on approved shop drawings. Provide manufacturer's standard stainless steel door units, AISI Type 302/304 with standard satin finish or No. 4 directional polish.

D. UL Labeled Door Units: Provide UL "B" labeled, self-closing door units (1-1/2 hour with 30 minute temp. rise of 250 deg. F., 139 deg. C.).

E. Hopper Discharge with Pedestal: 24" wide x 30" high, top hinged, self-closing stainless steel door and frame assembly, bearing Underwriters Laboratories, Inc., 1-1/2 Hr. "B" Temp. rise 30 minute 250 degrees F. Label, with 165 degrees fusible safety link closure assembly.

F. Sprinklers

1. 1/2" NPT sprinkler and flushing heads with 17/32" orifice above top intake. Additional 1/2" sprinkler head at every second intake above as required by local code.

2. Locate sprinkler heads above top intake ready for plumbing connection by others with 1/2" IPS 165 degree fusible link.

3. Provide additional 1/2" sprinklers at every second intake with mandatory.

G. Chute Supports: Four (4) each 3" x 2" clips welded to chute to attach to structural frame fabricated of 1-1/2" x 1-1/2" x 3/16" steel angles; typical each floor.

H. Vent

1. Provide full diameter vent through roof to 6'-0" above roof line.

2. Chute vent shall be open to atmosphere per NFPA 82:4-2.12.

I. Access Doors: Furnish UL "B" labeled 1-1/2 hour access doors for chute enclosure construction, where required for use and maintenance of chute and its components and accessories. Furnish self-closing, hinged and latched, steel door-and-frame units, primed for painted finish.

J. Sound Deadening: Factory-apply manufacturer's standard sprayed-on sound dampening material to chute sections.

1. Provide chute manufacturer's standard neoprene sound isolation pads under support brackets at each floor. If sound isolation pads are not standard with chute manufacturer provide products as recommended, for particular field conditions of project, by Mason Industries Inc., Hauppauge, NY.

K. Linen Chute Lock: Provide keyed flush rim cylinder lock keyed same for doors of chute, key removable only when cylinder is locked.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions where chutes are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

B. Verify that the chute may be installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.

3.2 INSTALLATION

A. General: Comply with chute Manufacturer's/Fabricator's instructions and recommendations. Assemble components with tight, non-leaking joints; and anchor securely to supporting structure with sufficient anchorages to withstand impacts from uses, and wind loading stresses on vent units. Provide for thermal expansion movement of chute sections. Except as otherwise indicated, install chutes plumb, without off-sets or obstructions, for free fall of materials within chutes. Install chute systems complete with doors, and with safety, sanitizing and fire-resistive components and accessories.

B. Coordination with Roofing: Where roof deck curb units are not shown to receive chute roof-termination vent units, anchor vent unit support flange directly to substrate before installation of roofing/insulation system. Install counterflashing after roofing/insulation system has been installed.

C. Intake and Discharge Doors: Install doors at standard heights and locations indicated. Provide anchorages, wall/chute interfaces, self-closing operation, and similar features of installation to comply with labeling and fire-resistive requirements for fire-resistive door construction. Interface door units with throat sections of chutes in a manner which will ensure safe, snag-proof, sanitary depositing of materials in chutes by users.

D. Sound Deadening: Install sound isolation pads as specified at bearing of chute supports at each floor level. Ensure that anchoring system is sufficiently resilient to inhibit transfer of impact sound to building structure.

1. Prior to installation of chute enclosure, touch-up with new material damaged areas of spray-on sound dampening material.

E. Access Doors: Deliver access door units to other trades at proper time for installation in construction of enclosure walls/floors/ceilings as indicated. Provide detailed information on required locations for operation/maintenance of chute systems.

F. Sign: Provide warning sign over each chute intake door in accordance with the requirements of local jurisdiction. Prior to ordering, submit sample sign for Architect's approval.

3.3 TESTING, ADJUSTING AND CLEANING

A. Test operate components of each chute system upon completion of installation; demonstrate use and safety features to Owner's personnel. Where possible, complete test operations prior to installation of shaft enclosure walls and ceilings.

B. Cleaning: Following completion of enclosure walls and ceilings, clean exposed surfaces of finished metal components of chute system. Remove foreign substances and repair imperfections in finishes, but do not remove UL labels.

END OF SECTION

DIVISION 21
FIRE SUPPRESSION

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 – GENERAL

1.1 REFER TO RELATED SECTIONS
Section 23 05 01 – Mechanical and Electrical Coordination
Section 23 05 02 – Basic Mechanical Requirements
Section 23 05 03 – Basic Mechanical Material and Methods
Section 22 10 00 – Piping and Equipment
Section 22 05 29 – Pipe Support and Anchors
Section 23 05 49 – Seismic Restraints
Section 22 05 53 – Plumbing Identification

PART 2 – NOT USED

PART 3 – NOT USED

END OF SECTION

SECTION 21 08 00

COMMISSIONING OF FIRE SUPPRESSION SYSTEM

PART I – GENERAL

1.1 REFER TO RELATED SECTIONS

A. Section 21 08 01 – Commissioning Agent Requirements

1.2 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplemental Conditions and Section 23 05 02 apply to all work specified in this section.

1.3 SPECIFIC REQUIREMENTS

A. All tests shall be made in the presence of the Architect or their representatives, and the local authorities having jurisdiction of the work to be tested, as may be directed. At least 72 hours notice shall be given in advance of all tests.

B. The Work of this Contractor shall include the furnishing of all testing instruments, gauges, pumps, compressors and other equipment required or necessary for tests, required by laws, rules and regulations and as specified. All tests shall be made at the expense of the Contractor.

C. Before any paint is applied, the combined sprinkler/standpipe system shall be tested hydrostatically at not less than 250 psi pressure for two (2) hours minimum. In addition to this testing, provide all other tests and certifications required by the local inspectors, Factory Mutual and all other Authorities Having Jurisdiction.

D. Systems installed in multiple phases shall be tested at the completion of each phase. Portions of systems that need to remain in service during construction shall be tested before return to service if taken off-line to complete work. Provide hydraulic calculations for each phase if systems are brought online in a state of partial completion that may impact hydraulics.

E. All appurtenances shall be operated after installation to confirm proper operation.

F. If the installation fails to meet testing requirements the Contractor shall determine, at his own expense, identify the source or sources of leakage or failure and shall repair or replace all defective materials or workmanship at no additional cost to the Owner. The completed pipe installation shall be re-tested after the defects have been corrected. No caulking on screwed joints, cracks or holes will be acceptable.

G. Tests are not permitted to be made with air except as noted.

H. All piping which is to be enclosed in partitions or hung ceilings shall be tested and made tight and tested when directed by the Construction Supervisor and in adequate time to permit the installation of partitions and ceilings. When necessary, the Contractor shall drain the piping and/or take over such precautions as required to prevent damage by freezing.

I. The Contractor shall be responsible for the Work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his Work, and he shall, without extra charges, restore to its original condition any Work so damaged or disturbed.

PART 2 – NOT USED

PART 3 – NOT USED

END OF SECTION

SECTION 21 08 01

COMMISSIONING AGENT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to section 21 08 00 for commissioning requirements and Division 1 for additional information.

1.2 DESCRIPTION OF THE WORK

A. This Section covers the Scope of Work for the Commissioning Agent (CA) who will be hired by the Owner.

B. The Commissioning Agent shall oversee the commissioning of the fire suppression systems as described in Section 21 08 00. The CA shall prepare pre-commissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.

C. The CA shall have authority to direct and schedule tests. The CA shall have no authority to direct changes to the construction of the systems.

1.3 COMMISSIONING PLAN

A. The CA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.4 COMMISSIONING FORMS

A. Review 100% CD's. Provide written summary of how each commissioned item of equipment should operate. Include calculations verifying scheduled capacity.

B. The CA shall develop forms similar to that in Section 21 08 00 for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and proved by the Owner prior to acceptance. Each form shall be signed by the Contractor, CA and Owner prior to acceptance of a system or piece of equipment.

1.5 COMMISSIONED SYSTEMS

A. All fire suppression systems in new and renovated spaces.

1.6 PROJECT OBSERVATIONS

A. The CA shall perform observations of the commissioned equipment and systems twice a month at a minimum and more as required to keep pace with construction. The CA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and Owner for resolution. The CA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the Owner, Architect and Contractor and shall be part of the final commissioning manual.

1.7 OPERATIONAL AND START-UP TESTS

A. The CA shall witness start-up tests and collect documentation of the tests. The CA shall notify the Architect and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

B. After the Contractor has submitted in writing that the systems are completed, the CA shall schedule and direct operational tests of the systems. These tests shall be as described in Section 21 08 00. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the Architect and Contractor. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

C. The presence or absence of a commissioning agent shall in no way relieve the installing contractor from his testing and supervision obligations.

1.8 COMMISSIONING MANUAL

A. The CA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:

1. Design and Energy Codes.
2. Commissioning Plan.
3. Completed Commissioning Forms.
4. Completed Observation Reports.
5. Completed Start-up Reports.
6. System Operational Tests.
7. Final sequence of operation to be achieved.
8. Summary of building operation as commissioned, noting deviations from design.
9. Design Criteria (extended from Design Documents by CA).
10. Written summary of normal startup and operating procedures for each commissioned item of equipment.

The manual shall be a three ring binder with tabs for each section. Provide 5 copies.

END OF SECTION

SECTION 21 13 00

FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete fire protection system as indicated on the Drawings and as specified herein consisting of the following but not limited thereto.

1. Complete combined manual fire standpipe and sprinkler systems including connections to new water service, fire department connections, fire valve stations, sprinkler heads, control valves, flow and tamper alarms, all required accessories, etc.
2. Dry system valves and controls.
3. Sleeve, hangers and supports.
4. Apply for, obtain and pay for all permits certificates, inspections and approvals required in connection with all Fire Protection Work.
5. Shop drawings: Shop drawings shall be produced in accordance with generally accepted standards for shop drawings and coordination drawings and shall be based on the Contractor's own field measurements. When a project is "phased" the Contractor shall anticipate that multiple filings may be required to allow permitting and approval of the project in a phased manner and shall prepare shop drawings and hydraulic calculations in packages matched to the final phasing plan.
6. All interlocking control wiring and conduit.
7. Color coding and stenciling of all piping systems.
8. Cutting and rough and finish patching.
9. Prime and finish painting of all pipe risers and mains.
10. Hydrant flow tests unless recent data is specifically indicated on drawings and age of test data provided is acceptable to Authority Having Jurisdiction for duration of project.
11. Provide hydraulic calculations and drawings signed and sealed by a licensed professional engineer all as required by applicable Building Code, FM Global Referenced Standards, and N.F.P.A. Code. Contractor shall replace Engineer as Engineer of Record.
12. Provide ladders to all valves more than 8'-0" above finished floor.
13. Tests for all systems provided under this Section of the Specifications.
14. Where due to Union regulations or trade agreements, any of the work shown on the Drawings or specified herein is not considered Fire Protection Contractor's Work, this Contractor shall sub-contract the work in question, but this Contractor shall be held responsible for the complete installation.
15. It is not the intention of these Specifications to describe, nor the Contract Drawings to show in detail, all the various pieces of apparatus and appurtenances and their connections. This Contractor shall, as part of the Contract, furnish and install all incidentals, such as piping, fittings, valves, etc., required to complete the installation of the equipment. This Contractor shall refer to Architectural Drawings for exact location of devices including type and quantities. This Contractor shall be responsible for providing and connecting all fixtures and equipment.
16. All work described in these Specifications and not shown on the Drawings, or vice versa, shall be installed in a manner similar to the work shown or described.
17. Sprinkler drawings shall be reviewed and approved by insurance underwriters prior to installation.
18. Approvals of cross-connection control devices for main water services: Prepare and submit to the Engineer, all drawings, applications, test reports, correspondence, etc., as required in connection with the approval and installation of the backflow preventors and/or double check valves, as indicated on the Drawings or as required by the New York State Department of Health. File all applications after approval by the Engineer. The Engineer will act as Engineer of Record and will sign and seal all contractor prepared applications as required.
19. All drains shall discharge to sanitary. Verify capability of existing drains to accept full flow discharge. If connection to sanitary sewer is determined to be infeasible or cost prohibitive, alternatives like splash blocks

to prevent erosion (during discharging water to grade) may be considered.

B. It is the intent of this Specification for the Contractor to provide complete hydraulically designed wet and dry pipe sprinkler systems for the areas indicated in these Specifications and shown on the Contract Drawings. This Contractor shall be the Engineer of record for the fire sprinkler system. Furnish all design, material, and labor to complete the contract within the intent of these Specifications and Contract Drawings even though each and every item necessary is not specifically mentioned or shown.

1.2 QUALITY ASSURANCE

A. Contractor Qualifications: Work shall be performed by a Contractor regularly engaged in the design and installation of fire protection systems in accordance with NFPA requirements and having at least ten years continuous experience in this type of work. Experience shall include projects of similar type, size and complexity.

B. Design Criteria: Provide fire protection systems of types, pressure, flow and densities required by regulatory agencies having jurisdiction.

1. Systems shall be calculated in a manner acceptable to regulatory agencies.
2. Contractor shall complete a hydrant test to confirm static and residual pressure for use in the hydraulic calculation. Contractor shall not assume that a prior hydrant test has been completed unless the test data is presented on the drawings. The Contractor shall complete all required hydrant tests or sub-contract this work to qualified testing parties.
3. Provide the following sprinkler head densities:
   .10 GPM/SQFT – Light Hazard
   .15 GPM/SQFT – Ordinary Hazard
4. Occupancy classification: Mixed – Light and Ordinary hazard.
5. Maximum sprinkler head spacing – based on NFPA Code: Light hazard- 225 sq.ft./sprinkler head. Ordinary hazard – 130 sq.ft./sprinkler head.
6. Calculations shall be based upon 1500 sq.ft. of the hydraulically most remote area of sprinkler operation for each system unless increased by dry systems or sloped ceiling. (30% increase for each condition).
7. Where source pressure allows, systems shall be sized for a minimum safety margin of 7 PSI. This margin is in addition to the 7 PSI code required minimum required at each head.
8. ME Engineers DOES NOT recognize NFPA's reduced demand area rules, and as such, they are not allowed for use in designing sprinkler systems.

C. Pipe sizes shown on drawings may be larger than minimum required. This is to accommodate additional partitioning which may occur in the future. Do not reduce sizes.

D. Requirements of Regulatory Agencies: Total system shall be acceptable upon completion and testing to the following:

1. Jurisdictional Code Enforcement Agencies
2. Jurisdictional Insurance Agency or Underwriter
3. Confirm requirements of the authority having jurisdiction and Owner's Insurance Underwriter prior to bid.

E. The Contractor shall give necessary notices, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefore.

F. Certificate of Installation: Submit certificate upon completion of fire protection work, stating that the work has been completed and tested in accordance with the specified standards, that there are no defects in the system and it is operational.

G. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.3 CODES AND STANDARDS

A. In addition to those specified in Section 21 05 02, comply with local fire department regulations and with the following:

1. Local Water Department
2. Local Building Department
3. Local Health Department
4. Poughkeepsie Department of Buildings
5. NFPA 13, 14, 24, 231C
6. Local modifications to the Fire Codes
7. UL 508 Industrial Control Equipment
8. NFPA 70 National Electrical Code

B. All materials and equipment used in the installation of the fire protection system shall be as approved in the Underwriters' Laboratories list of inspected fire protection equipment and materials, or the Factory Mutual Laboratories list of approved equipment and fire protection devices involving fire hazard, and shall be the latest product of the manufacturer, and shall bear their label.

1.4 SUBMITTALS

A. Submittal data shall be in accordance with Division 1 and the following shall be submitted for review to the Architect prior to the start of installation.

B. Material and equipment information shall include catalog cuts and technical data for each system component or device. This shall include, but not be limited to piping, fittings, globe and angle valves, O.S.&Y valves, butterfly valves, check valves, automatic sprinkler heads, escutcheons, hangers, flow switches, tamper switches, dry pipe valves, fire pumps, jockey pumps, pre-action valves, air maintenance device and air compressor.

C. Prepare shop drawings showing layout of fire protection system and piping. Use minimum scale of 3/8" = 1'-0" for floor plans. Drawings shall be based on the Contractors field measurements and information collected in coordination meetings, discussions and correspondence with other trade contractors and shall reckon with all building components and show routing of piping to clear same. Drawings shall be accurately dimensioned to show proposed location of all fire protection system components. Drawings shall be of sufficient detail to allow the creation of a bill of materials for off-site fabrication of at least 90% of the installed system piping. System design shall be completely coordinated with the architectural, structural, mechanical, and electrical features of the building. The drawings shall show all details required by NFPA 13. In all areas with suspended ceilings, reflected ceiling plans shall be prepared showing the location of sprinklers, lights, diffusers, grilles, etc. Drawings shall be suitable for filing with DOB, FM and FDNY. Contractor and Contractor's Engineer shall complete these filings with DOB and FM.

D. On some projects the Owner will insist that the Engineer provide CAD files of the Engineering drawings for the Contractor's use. When the Contractor has been provided with the Engineer's CAD files, these files shall not be used to prepare the as-built drawings and drawings similar to the Engineer's contract drawings will not be accepted as as-built drawings.

E. Submit a complete schedule of the material and equipment proposed for this installation to the Architect/Engineer for approval. Include catalog cuts, diagrams, drawings, and such other descriptive data as may be required to clearly show what is intended to be installed and how. In the event any items of material or equipment contained in the schedule fail to comply with the specifications, such items may be rejected.

F. Submit to the engineer five (5) sets of blueprints and hydraulic calculations signed and sealed by a Professional Engineer retained by the contractor. After approval by the engineer, submit three (3) copies of the drawings and hydraulic calculations of the sprinkler system to the regulatory agencies having jurisdiction, including FM Global. Update the drawings to reflect any comments and resubmit the drawings until approval is obtained. Upon receipt of approval submit the drawings and hydraulic calculations to the Architect for record. Approval of the Architect must be obtained before purchasing or installing any equipment. Submissions shall be signed and sealed by an Engineer retained by the fire protection contractor.

G. Approval of submittals will not relieve the Contractor of the responsibility for correcting any errors which may exist or for meeting requirements of the specifications. No partial submittals will be accepted.

H. A set of approved installation drawings shall be kept at the job site and marked to indicate all installation conditions which are different from the approved drawings.

I. In the event that the contractors final design deviates from the bid documents and a re-filing is required, the contractor shall prepare all documents required for the re-filing and provide adequate copies signed and sealed by an engineer retained by the contractor. Contractor shall also execute any documents required to replace Engineer as Engineer of record if Engineer has previously served as Engineer of Record.

J. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable manufacturer style or series number.\

K. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification (SIN) or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

L. Manufacturer's Data: Submit manufacturer's product data for fire protection valves including:

1. Dimensions
2. Sizes
3. End Connections
4. Weights
5. Installation instructions
6. Instructions on repacking and repairing valves.
7. Range of flow for balancing valves and plug valves.

M. Valve Tag List: Refer to Section 22 05 53 of the Specifications.

N. The final project submittal shall be an as-built drawing signed and sealed by the contractor's Engineer. The as-built drawing shall document the final installed condition of the fire protection system and shall meet the as-built filing requirements of the Authority Having Jurisdiction.

1.5 GREEN BUILDING REQUIREMENTS AND PERFORMANCE CRITERIA

A. Green Building Performance Criteria:

1. All field-applied concrete admixtures, adhesives, sealants, paints and coatings used for interior applications shall meet the volatile organic compound (VOC) and chemical component limitations as defined by national standards.

B. Green Building Submittal Requirements:

The Contractor and their sub-contractors shall submit the GREEN BUILDING CERTIFICATION items listed herein.

1. GBMCF: Submit a completed GREEN BUILDING MATERIALS CERTIFICATION FORM. A copy of the GBMCF is appended to Section 018113 “Sustainable Design Requirements”. Information to be supplied for this form shall include cost breakdowns for the materials included in the Contractor or sub-contractor’s work with cost breakdowns identifying total cost and itemized material costs for any VOC containing products.
2. Validation: Published product literature or manufacturer’s letter of certification (on the manufacturer’s letterhead) validating all information, other than costs, provided in the GBMCF.
3. Cut Sheets: Product cut sheets for materials listed in the GBMCF. Cut sheets shall be submitted with the Contractor or Trade Contractor’s stamp, confirming that the submitted products are the products installed in the Project.
4. VOC Content: Material Safety Data Sheets (MSDS), published product literature, or manufacturer’s signed certification (on manufacturer’s letterhead) stating the VOC content of all applicable products.
5. Submittal Package: The GREEN BUILDING submittal information shall be assembled into one (1) package per Section or trade, and sent to the Consultant for review. Incomplete or inaccurate Green Building submittals may be used as the basis for rejecting the submitted products or assemblies.

1.6 DESIGN REQUIREMENTS

A. Engineer’s bid documents are provided to define the scope of the sprinkler work and the general arrangement of systems. It shall be the Contractor’s responsibility to size the sprinkler system pipes in accordance with the requirements of NFPA. Contractor shall submit all calculations to the Engineer for review at time of drawing submittal. Submittal of these calculations to the Engineer will in no way relieve the Contractor of his responsibilities for complete and proper design of the fire protection system. Upon preliminary approval by the Engineer, the Contractor shall prepare a complete set of filing documents for submission to DOB and FM. Filing sets shall be developed in phases as required to allow partial filings and approvals in support of the phasing plan developed for the project. All filings shall include plan drawings suitable for DOB filing and hydraulic calculations as required to support proposed pipe and pump configuration and sizing.

B. The Contractor shall fully inform himself regarding any special characteristics and limitations of the space available for the installation of all materials under Fire Protection Work.

C. The contractor shall ascertain that all his equipment, such as pumps, valves, flow switches and such other apparatus as may be necessary to be reached from time to time for operation and maintenance is made easily accessible for operation and maintenance.

D. Existing conditions revealed during demolition may identify conflicts with the building construction. The contractor shall call the Architects attention to this fact before installing this work and shall be guided by their instructions.

E. The contractor shall prepare calculations in accordance with N.F.P.A., Chapter 13, Insurance Carrier Specifications and requirements herein indicated. Calculations shall be prepared for as many areas of application as necessary to demonstrate to the satisfaction of the Insurance Carrier, Building Department and Architect that the system meets the herein outlined criteria.

F. It shall be the Contractor’s responsibility to design the system so that no interferences exist between the fire protection system and work of other trades, equipment and systems designed and installed by others. The latest issues of all architectural, structural, mechanical and electrical drawings shall be reviewed to assist the Contractor in preparing the design so as to avoid interference.

G. This Contractor shall provide all necessary control wiring and equipment necessary for an operational system. This includes, but not limited to, key switches, releasing panels, solenoid valves, etc.

H. Any fees charged by local first responders for false alarms associated with construction activities or installation related conditions will be the responsibility of the Contractor.

I. The Drawings are diagrammatic and indicate the general arrangement and location of equipment, piping, sprinkler heads, etc. Make modifications in the layout work that may be required to suit actual job conditions without extra

compensation. Provide additional heads and branch piping for a code compliant system, if necessary, at no additional cost to the Owner.

J. Drawings and Specifications are intended to be fully cooperative. Any materials, equipment, or systems related to this Section and exhibited on the Architectural and Fire Protection Drawings but not mentioned in the Specifications are to be executed to the intent and meaning thereof, as if it were both mentioned in the Specifications and set forth on the Drawings.

K. Should any discrepancy or apparent difference occur between Drawings and Specifications or should occur in the work of others affecting the work, the Contractor shall notify the Architect immediately. If the Contractor proceeds with the Work affected without instructions from the Architect, he shall make good any resultant damage or defect. All misunderstandings of Drawings and Specifications shall be clarified by the Architect.

1.7 EXAMINATION AND COORDINATION

A. The Drawings are diagrammatic and indicate the general arrangement of systems and work indicated under this Section. (Do not scale the Drawings). The Contractor shall consult the Architectural Drawings and Details for exact locations of fixtures, and equipment; where same are not definitely located, he shall obtain this information from the Architect.

B. The Contractor shall follow the Drawings in laying out work and check Drawings of other trades to verify spaces in which work will be installed and maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Architect shall be notified in writing. The installation shall not proceed before receiving the Architect's written instructions.

C. If directed by the Architect, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades, maintain required headroom and space conditions, and for proper execution of the work.

D. Where variances occur between the Drawings and the Specifications, or within either document itself, the item or arrangement of better quality, greater quantity, or higher cost shall be included in the Contract. Architect will decide on the item and manner in which the Work shall be installed and his decision shall be final.

E. It shall be the responsibility of the Contractor to closely schedule his work so that his work will be installed at the proper time and without delaying the completion of the entire Project.

F. Where the Fire Protection Work will be installed in close proximity to the Work of other trades, or where there is evidence that the Work of the Contractor will interfere with the Work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. The Contractor shall work with all trades to prepare composite working drawings and sections at a suitable scale not less than 3/8" = 1'-0" clearly showing how his work is to be installed in relation to the Work of other trades. If the Contractor installs his Work before coordination with other trades or so as to cause interference with Work of other trades, he shall make necessary changes in his Work to correct the condition without extra charge.

G. Study the Drawings and Specifications in order to insure completeness of the Work required under this Section. Supplementary items normal and necessary to complete the Work, though not definitely shown or specified shall be included.

H. Verify all measurements and conditions in the field before starting work.

I. Examine all surfaces to which Work under this Section is to be applied and notify the Architect in writing if any conditions exist which are detrimental to the proper and expeditious installation of Work. Starting of Work shall be understood to be acceptance of surfaces.

J. If it should be necessary to remove and relocate any material or equipment that has been installed without proper investigation and coordination with the work of other Sections, such materials or equipment shall be removed and relocated without additional cost to the Owner.

1.8 WATER SUPPLY

A. The water supply, as shown on the drawings, will be installed by the Plumbing Contractor, who will provide a flanged connection inside the building for the fire protection system. The fire protection Contractor shall make the required connection at this point for the fire protection system.

1.9 WARRANTIES

A. The entire new system shall be warranted to be free from defects for a period of one (1) year from the date of Notice of Acceptance.

1.10 PROJECT RECORD DOCUMENTS

A. Upon completion of the work, the Contractor shall revise all fire protection drawings to agree with the construction as actually accomplished and stamp “As-Built”. Those drawings where no change is involved shall be likewise stamped. These “As-Built” drawings shall show the fire protection system as it existed at the completion of the contract work.

B. On some projects the Owner will insist that the Engineer provide CAD files of the Engineering drawings for the Contractor’s use. When the Contractor has been provided with the Engineer’s CAD files, these files shall not be used to prepare the as-built drawings and drawings similar to the Engineer’s contract drawings will not be accepted as as-built drawings.

C. See Division 1 for additional requirements.

1.11 CLEANING, PROTECTION AND ADJUSTING

A. The Contractor shall be responsible for the protection of all fire protection of all fire protection systems equipment against breakage or damage at all times until final acceptance of the job

B. All openings left in floor for passage of supply pipes shall be covered and protected. Due precautions shall be taken against freezing during cold weather. All pipes shall be protected with suitable coverings as soon as set. All open ends of pipes shall be closed by a plug fitting to prevent obstruction and damage.

C. The Contractor shall frequently clean up and remove from the Site all rubbish, scrap materials and debris caused by his Work, and upon completion of the Work and before final payment is made, he shall remove from the site all surplus material, temporary structures, tools and all debris resulting from his operation.

1.12 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General Conditions of the Contract and Supplementary General Conditions and Division 1 - General Requirements, apply to work of this Section. This Contractor shall comply with all applicable sections of Divisions 21 through 23.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe joints above ground shall be screwed, flanged, welded, or mechanical couplings. Welded joints are not acceptable in pipe less than 2" in diameter. No welding permitted except with certified welders in shop. No field welding of sprinkler pipe will be permitted. No field made weld-o-lets are permitted.

B. All above ground piping shall be schedule 40 black steel pipe. The use of schedule 10 (thin wall) piping is NOT permitted. All exposed fire protection piping shall have screwed fittings. Concealed piping can use screwed or rolled groove fittings.

C. Below grade piping shall be ductile iron pressure pipe, tar coated, cement lined, ANSI A21.51, Class 50 with ANSI 21.10 fittings and ANSI 21.11 rubber gaskets.

D. Screwed fittings above ground shall be gray cast iron suitable for 175 psi cold water working pressure and so rated. Provide valves with an elevated pressure rating for work in buildings more than 350 feet tall.

E. Sprinkler piping and fittings for dry pipe systems shall be galvanized, schedule 40 minimum. All fittings on galvanized piping shall be galvanized in accordance with ASTM A153.

F. Mechanical fittings shall be as follows:

1. Grooved end fittings shall be UL/FM approved, full flow, short radius ductile iron conforming to ASTM A536, or carbon steel conforming to ASTM A53 with factory grooved ends designed to accept mechanical couplings.

2. Grooved mechanical couplings shall be UL/FM approved, consisting of two ASTM A536 ductile iron housings, a pressure-responsive, synthetic rubber gasket, and plated steel bolts and nuts.

a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9

1) 1-1/4" through 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock EZ Style 009.
2) 5" and larger: Standard rigid couplings. Victaulic FireLock Style 005 or Style 07 Zero-Flex.

b. Flexible Type: Use in seismic areas where required by NFPA 13.
1) 2" through 8": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic.
2) 10" and larger: Standard flexible couplings. Victaulic Style 77.

3. Coupling gaskets shall be listed for use as follows:

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal, GapSeal or Tri-Seal, Grade EPDM, Type A or E
Freezer Applications	-30°F to 0°F (-34°C to -17°C)	FlushSeal, GapSeal or Tri-Seal, Grade EPDM Type A or E
Water/Wet Systems	Ambient	C-Shape, Grade EPDM, Type A

4. Flange adapters shall be ASTM A536 ductile iron, flat faced, designed for incorporating flanges with ANSI Class 125 or 150 bolt-hole patterns to a grooved piping system. Victaulic Style 741 or 744.

G. All sprinkler pipe threading shall be completed with fixed diameter threading dies.

2.2 BUTTERFLY VALVES

A. Butterfly valves shall be furnished with slow closing worm gear type indicating operator. Valves shall have a completely sealed shaft, integral flange seals and hex drive. Valves shall be rated for 175 psi maximum pressure rating.

B. Grooved end butterfly valves shall be furnished with a weather-proof actuator with pre-wired supervisory switches. Ductile iron body, nickel-plated ductile iron disc, Type 416 stainless steel two-piece stem and Nitrile seat, up to 365 psi CWP rating.

1. Supervised in the open position: Victaulic Series 765 or Series 705
2. Supervised in the closed position for fire pump metering test lines and rooftop test units: Victaulic Series 766 or Series 707C

2.3 O.S.&Y. VALVES

A. Outside stem and yoke gate valves shall be of the wedge disc type and shall permit straight line flow and complete shut-off. Valves shall be designed to allow packing under full pressure when wide open. Valves shall have bronze mounted, resilient wedge type, grooved ends or grooved by flanged ends, ductile iron body, cast iron bonnet and disc with EPDM disc coating, and brass stem. Valve shall be rated for 250 psi maximum pressure rating. Victaulic FireLock Series 771 or Kennedy Model 7092.

B. Provide valves with an elevated pressure rating for work in buildings more than 350 feet tall.

2.4 CHECK VALVES

A. All swing check valves shall be 175 psi non-shock cold water service, iron body, bronzed trim, horizontal swing with renewable bronze seat and rings. All check valves two (2) inches and smaller shall be bronze, screwed, horizontal swing type. All check valves two and one half (2½) inches and larger shall be flanged or grooved type. Provide automatic ball drip where valve is subject to freezing. All check valves shall include removable face plate

B. All water check valves shall be 175 psi working pressure, iron body with spring actuated double bronze plate and rubber seat with UL Listing and FM approval.

C. Provide valves with an elevated pressure rating for work in buildings more than 350 feet tall.

D. Grooved end check valves shall have a pressure rating up to 365 psi CWP, ductile iron body, stainless steel or EPDM coated ductile iron disc, stainless steel spring, nickel-plated or welded-in nickel seat.

1. 2” through 3”: Victaulic FireLock Series 717H and 717HR (365 psi CWP).
2. 4” through 12”: Victaulic FireLock Series 717 and 717R (300 psi CWP).
3. 2-1/2” through 8”: Viking G-1 (300 psi CWP)

2.5 GLOBE AND ANGLE VALVES

A. Valves shall be furnished with renewable disc, non-shock, and shall back seat in the fully opened position to allow repacking under full pressure without removing the valve from the line. Valve shall be rated for 175 psi working pressure.

B. Provide valves with an elevated pressure rating for work in buildings more than 350 feet tall.

2.6 PRESSURE REDUCING VALVES

A. Provide pressure reducing valves on all systems served by storage tanks and at any location where branch piping or sprinkler heads would otherwise be exposed to a pressure above 150 psi.

2.7 AIR COMPRESSOR

A. The air compressor shall be an electric motor-driven, air-cooled, single-stage, oil-less compressor. It shall be sized compatible with the system type and size. Compressor shall be of adequate capacity to fill sprinkler system in 30 minutes or less.

B. Approved manufacturers are General Air, Gast Mfg., Notifier, Potter-Roemer, ACME or equal.

C. Provide vibration isolation (floor mounted spring and neoprene) for all air compressors, Mason Type SLF or equal.

2.8 VALVE SUPERVISORY SWITCHES

A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact.

B. Provide tamper switches on all valves in the fire line.

C. Switch shall be approved for use on the type of valve to be monitored.

D. Approved manufacturers are Potter Electric, System Sensor, or equal.

2.9 FLOW SWITCHES

A. All flow switches shall be field adjustable vane type with pneumatic retard and 175 psi working pressure. Units shall be suitable for installation by drilling pipe and securing with U-bolt furnished with the switch.

B. All zone flow switches shall be Potter Electric Zone Check assemblies.

1. Assembly shall include vane type waterflow detector factory installed on assembly. Waterflow switches shall be adjusted so that the device will transmit a waterflow alarm within 30 seconds of opening the inspector's test valve on the sprinkler system. Units shall be single pole double throw, suitable for 24 volt D.C. service with one normally open contact and one normally closed contact.
2. Assembly shall include circulation pump for inspection of flow switch without discharge of water from the system. Pump shall be 120V, single phase, 60 hz, 185 W maximum. Pump shall be factory installed on assembly with inlet/outlet valve.
3. Assembly shall be provided with key-switch for testing of flow switch. Key-switch shall include local LED signals for test initiation and flow switch activation.

2.10 EXTERIOR ALARM

A. Approved manufacturers are Potter, Farr Alarm, Notifier or approved equal.

B. Alarm shall have combination horn and light and be constructed for exterior use.

C. Furnish interior alarms where required by the authority having jurisdiction.

D. Integrate alarm with fire alarm system where one is provided.

E. Locate on exterior wall adjacent to fire department connection and post indicator valve of service.

2.11 DRY PIPE VALVE

A. Valve shall be UL listed and FM approved.

B. Valves shall be sized as follows:

Pipe Serving Dry Zone	Reliable Sprinkler Model	Viking Model
2½" and smaller	Model A Dry Pipe Valve	F or G Dry Pipe Valve
3" - 6"	Model D Dry Pipe Valve	F or G Dry Pipe Valve
8"		F or G Dry Pipe Valve

C. Valve shall have flanged connections, gasketed hand hole cover, brass-to-neoprene air seat, brass-to-brass water seat, spring-loaded clapper with full open latch. Provide all accessories consisting of angle valves, globe valves, pipe nipples and fittings, water and air pressure gauges, accelerator or exhauster when required and maintenance air compressor sized in conformance with NFPA 13.

D. Grooved end dry pipe valve shall separate system water supply from the air filled system piping. Valve shall have grooved end connections for vertical installation only, and shall be low differential, latched clapper design. Ductile iron body, aluminum bronze clapper, EPDM diaphragm and seal with brass seat and Nitrile seat o-rings. Valve internal parts shall be replaceable without removing the valve from the installed position and shall be externally resettable. Water working pressure is 300 psi in all sizes and 13 psi minimum required air pressure with Series 776 low pressure actuator. Valve shall be provided pre-trimmed with all necessary piping, shutoff valve, pressure switches, and gauges. Re-work trim in field if necessary to adapt to space constraints.

2.12 EXTERIOR, FIRE PROTECTION VALVES

A. Furnish and install an Undrewriters' approved Stockham Valve Co., Inc. Fig. G635-0 or approved equal or as required by Local Authorities, with glands, gaskets, cast iron bolts, nuts and Kennedy Fig. 121 three piece screw type valve box to grade. Each valve shall have a cast iron body with brass valves spindle and internal parts, non-rising stem, parallel seats and mechanical joints ends. Valve box cover shall have the word "FIRE" cast in the cover. Provide with each valve a Kennedy Fig. 122 valve wrench to suit the depth of bury. Valves shall be left open.

B. Valves and valve boxes shall be installed in the lines as shown on the Drawings, and shall be set plumb and centered with valve boxes placed directly over the valves. Earth fill shall be carefully tamped around the valve box to a distance of 4 feet on all sides of the box or to undisturbed earth if excavation is less than 4 feet.

C. Vertical Indicating Post (V.I.P) shall be UL and FM listed and shall be similar to Stockham Fig., No. G-951 – For trench depth of 3'-6" to 5'-6".

2.13 BACKFLOW PREVENTER DOUBLE DETECTOR CHECK

A. Manufacturer:
1. Design Basis: Watts No. 709DCDA (3" through 10") Double check detector assembly for fire protection service
2. Construction: Epoxy coated cast iron body, replaceable bronze seats.
3. Other Acceptable Manufacturers:
   a. Febco
   b. Wilkins
4. Complies with ASSE STD 1048.

2.14 AUTOMATIC FIRE SPRINKLER HEADS

A. Sprinkler heads shall have a temperature rating of 165ºF except for heads in areas of high temperature and in close proximity to heat sources which shall be temperature rated in accordance with NFPA 13.

B. Sprinkler heads in ceilings to be concealed pendant.

C. Sprinkler heads in dry-pipe systems shall be upright (where exposed) or dry-pendant type (in finished ceilings and where installed in a pendant configuration).

D. Supply Owner an extra stock of six sprinklers minimum, three of each type, and any special required sprinkler wrench. Heads shall be packed in a suitable container for wall mounting. Provide additional heads that may be required by NFPA 13.

E. Sprinkler heads shall be Underwriters' Laboratories approved cast brass quick response wet type with 1/2" discharge orifice where scheduled as K-Factor 5.6 and 17/32" discharge orifice where scheduled as K-Factor 8.0. Sprinkler heads with reduced orifice shall be provided where approved by code and required to address a limited water supply condition.

F. Any and all sprinkler heads placed in location where they are liable to be accidentally hit in the normal course of building occupancy shall be provided with heavy wire guards. Guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer. Locations include, but are not limited to, above cable trays, within mechanical or storage rooms below 8 feet, and loading docks.

G. In the instance where sprinkler escutcheon are used (horizontal sidewalls & pendent), the escutcheon shall be UL Listed with the specific sprinkler head.

H. The sprinkler heads in all areas are to be installed on a true axis line in both directions with a tolerance of ±1/2". At the completion of the installation, if any heads are found to exceed the above shall be corrected and any adjoining work that may be disturbed in reinstalling heads shall be repaired or replaced at no additional cost to the Owner. All heads installed in hung ceilings shall be located on the centerlines of tiles.

I. Sprinkler heads shall be as follows. Substitution of equivalent products from approved manufacturers permitted:

Area	Head	Reliable Model #	Viking Model #	Tyco Model #
Finished spaces and corridors	Fully recessed, concealed type. White painted cover, except at wood ceilings. Coordinate cover color in wood ceilings with Architectural finish.	G5-56	VK462	TY3531
Guest room sleeping areas	Fully recessed, concealed horizontal sidewall. Extended coverage. Custom cover color. Coordinate with Architect.	G6-80	VK680	TY4522
Unfinished spaces and corridors	Standard upright/sidewall head, brass finish	F1FR	VK300	TY313
Mechanical Rooms, storage, room without finished ceilings	Standard upright/sidewall head, brass finish with wire guard.	F1FR	VK300	TY313

Loading docks, areas exposed to freezing, head extended into attic or unheated cavity	Dry head, length shall be determined by space conditions.	F3QR	VK180	TY323
Mechanical rooms with finished ceilings	Standard semi recessed pendant head.	F1FR	VK302	TY313

2.15 FIRE DEPARTMENT CONNECTION

A. Approved manufacturers are Potter-Roemer, or equal.

B. Fire department connection shall be 2-way projecting inlet with self-closing clapper valves, pin lug swivels and caps with chains equal to Potter-Roemer Series 5720 and Potter-Roemer escutcheon plate Series 5960 with appropriate lettering. Furnish with type of thread as directed by the local fire department.

C. Provide ¾" automatic ball drip.

D. Fire Department connection shall be painted and labeled to meet local requirements.

E. FDC shall be located a minimum of 18" above grade. For installed heights above 18", a 22.5-degree elbow shall be provided.

2.16 FIRE HOSE VALVE

A. Approved manufacturers are Potter-Roemer, or equal.

B. 2½" Hose valve with 2½" x 1½" reducer with pin lug cap and chain, polished brass finish equal to Potter-Roemer 4065-B.

C. Provide pressure reducing hose valve where system pressure at hose valve exceeds 100 psi.

2.17 FIRE VALVE CABINET

A. Approved manufacturers are Potter-Roemer, or equal.

B. Fire valve cabinet shall be recessed 20 gauge, white, baked enamel steel box, 20 gauge tubular steel door with 18 gauge frame with a continuous steel hinge (brass pin), door and frame finished with a baked-on gray primer coat equal to Potter-Roemer 1810 series. Coordinate vision glass with fire extinguishers provided by others and requirements of local jurisdiction.

C. Cabinet shall contain 2½" hose valve, pin lug cap and chain equal to Potter-Roemer. Threads shall be as required by local fire department.

D. Hose valves shall be centered in cabinets to allow adequate clearance for gloved-hand operation.

2.18 ROOF MANIFOLD

A. Approved manufacturers are Potter-Roemer or equal.

B. Cast brass 3-way outlet body with threads to match requirements of local fire department.

C. Control valve shall be non-rising stem Kennedy No.701X or equal with wall post indicator Kennedy No. 541S or floor stand Kennedy No.118 as required.

D. Provide ball drip between outlet and control valve. Drain through face plate.

2.19 INSPECTOR'S TEST AND DRAIN CONNECTION ASSEMBLY

A. Victaulic Co. No. 720 TestMaster II or approved equal.

2.20 ALARM FACILITIES

A. Equipment necessary to accomplish a transmitted waterflow signal and auxiliary contacts shall be provided. Main shut-off valves shall be electrically supervised. Any tamper-proof switches required for testing the sprinkler system shall be furnished. Alarm devices shall be as manufactured by Potter Electric Signal Company or approved equal. Provide all devices required for proper transmission of all alarms to main fire alarm control panel. Wiring shall be provided in Division 26.

2.21 INSPECTOR TEST CONNECTIONS AND DRAINS

A. Furnish and install Inspector Test Connections and drains, piped to suitable plumbing drains, to allow for testing and maintenance of all parts of the system. Provide additional supplemental drains at all system low points.

2.22 MISCELLANEOUS

A. Nameplate data information: The nameplates shall be installed on each main riser and shall include the following design data: building designation, location of remote area, design density, area of application, and system demand (GPM and PSIG at base of riser).

B. Control valve signs: The Contractor shall provide a description sign, minimum dimensions seven (7) inches by nine (9) inches, for every valve in the system which controls water to sprinkler heads. Signs shall be single faced, white letters on a red background, with a space designating who to notify if valve needs to be closed. Signs shall be fastened to each valve with lightweight chain.

C. Miscellaneous signs: Signs for alarm test valves, main drains, auxiliary drains, etc. shall have minimum dimensions of two (2) inches by six (6) inches. Signs shall be single faced, white letters on a red background. Each sign shall be fastened to each valve with lightweight chain.

D. Provide (2) 11 x 17 copies of approved system diagram. One shall be mounted in a glazed frame as directed by Architect, the second shall be provided to the Owner for file.

E. Provide a sign at the base of each riser describing the design criteria of the system.

2.23 PIPE HANGERS

A. Provide products which are Underwriters Laboratories listed.

B. Provide pipe hangers and supports of which materials, design, and manufacture comply with ANSI/MSS SP-58, MSS SP-69, MSS SP-89.

C. Assume the responsibility for the proper transfer of the loads of the piping system to the structure. No additional cost to the Owner should be expected for any corrective work during construction. All pipe supports shall be of type and arrangements as hereinafter specified and shall be so arranged as to prevent excessive deflection and avoid excessive bending stresses between supports. All auxiliary steel for pipe supports shall be furnished and installed by this Contractor, where overhead construction does not permit fastening of hanger rods in required locations.

D. Supports and hangers shall be provided for all horizontal and vertical piping. The hanger design shall conform to the ASA Code for Pressure Piping.

E. All bracket clamps and rod sizes indicated in these Specifications are minimum size only. This Contractor shall be responsible for structural integrity of all supports. All structural hanging material shall be selected for a factor of safety of five (5).

F. Pipe supports shall be of the following type and figure number as manufactured by Anvil.

Pipe Hanger Schedule:

Item	Anvil Fig. #	Piping Sizes
Beam Clamp	92	All
Beam Clamp w/Retaining Clip	87	All
Clevis Hanger	260	8" and Smaller
Pipe Saddle	264	4" and Larger
	192	2, 2-1/2", 3"
Riser Clamp	261	All
Stand Off Pipe Clamp	103	All
Brackets	195, 199	All
Steel Washer Plates	60	All
Concrete Insert	CB 282	All

G. Pipe Supports in Pipe Chases: Supports shall securely hold piping prevent vibration, etc. Provide supplemental pipe supports and channels as required.

H. In grooved piping systems, Victaulic Style 009, 005, and 07 rigid couplings may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate number of Victaulic Style 177, 75 and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.24 PRESSURE GAUGES

A. Pressure gauges shall be rated for 150% of working pressure.

B. Gauges shall be FM approved and UL listed.

C. Provide pressure gauges where shown on details, as well as at the top of existing and new standpipe risers.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. The Contractor shall investigate the conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. The Contractor shall field verify all dimensions and conditions governing his work at the building. Materials shall not be fabricated or delivered to the

site before the approved shop drawings and equipment submittals have been received by the Contractor.

B. Entire installation shall be in accordance with approved shop drawings. When unforeseen job site conditions will not permit piping to be installed as shown on the drawings, necessary changes will be made to accomplish a coordinated system without additional cost to the Owner, even though pipe may have been delivered to the site cut to pre-determined lengths.

C. Provide gate valves of size and at locations shown on the drawings and any additional valves required by local authorities. Locate all valves where readily accessible. Provide chain wheel operators or permanent ladders for all valves not accessible from the floor. All main line valves shall be electrically monitored and secured with a chain and padlock which will lock the valve in an open position.

D. Provide check valves of size and at location shown on the drawings and any additional check valves that might be required by local authorities.

E. Provide valved test drains as required by NFPA. Pipe test drains to spill to nearest floor drain, or receptor. Make provisions to drain all parts of the piping system for service including additional drains at all system low points.

F. Hydraulic calculations shall be performed in accordance with the requirements of NFPA 13 and 14. The Contractor shall calculate the demand point for the system so that it remains ten (10) percent below the final water supply curve at the connection to the public water system. The demand point for the systems shall include an allowance for the inside and outside hose demand. The basis for the hydraulic calculations shall be determined by a waterflow test performed by the Contractor and acceptable to the Authority Having Jurisdiction.

G. Be responsible for trenching, bedding material, removal of waste material, paving removal and replacement, barricades, and any materials necessary for vehicle and person access across work areas.

H. Bedding shall be well graded non-expansive, non-organic soil containing no rocks over one (1) inch in diameter. There shall be no refuse or corrosive materials in this soil.

I. All bedding and backfill shall be laid and compacted in accordance with excavation and backfill requirements described elsewhere in the specification.

3.2 PIPING INSTALLATION

A. Perform the work in a professional workmanlike manner, according to the best practices of the trade. All sprinkler piping must be substantially supported from the building structure and only approved type hangers shall be used. Sprinkler piping in all areas shall be concealed unless otherwise noted on the contract drawings. In those noted locations and in areas with no ceiling, piping shall be installed as high as possible using necessary fittings and auxiliary drains to maintain maximum height. Any deviations found necessary shall be immediately brought to the attention of the Architect. All piping discharging outside (main drains, Inspectors Test Connections, etc) shall do so on paved surfaces or splash blocks.

B. All inside piping shall be joined by means of screwed, flanged, flexible gasketed joints, or other approved method. Risers, feed mains, cross mains, and branch lines may be shop welded using approved welding fittings and conforming to the standards as set forth in the latest edition of NFPA 13. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler system piping on-site.

C. Provide escutcheons on penetrations of interior walls. Chrome or white -plated escutcheons shall be provided where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with set screws or spring clips. Color is subject to architect/owners approval. All escutcheons for sprinkler heads must be UL Listed with the specific sprinkler head.

D. It is the intent that each part of the Fire Protection Systems shall be complete in all details and all lines provided with all control valves as indicated on Drawings, or as may be required for the proper control of the pipe lines under this Section so that any fixture, line or piece of apparatus may be cut out for repair without interference or interruption of the service to the rest of the building.

E. Run piping straight and as direct as possible. In general, form right angles with or parallel to walls or other piping. Risers shall be erected plumb and true.

F. All dry pipe system piping shall be installed with a pitch per NFPA 13 standards.

G. After cutting, all pipes shall be reamed out to full bore and before erection the inside of all pipes shall be thoroughly cleaned.

H. No piping or work shall be concealed or insulated until all required tests have been satisfactorily completed and work has been approved by the Architect and all other authorities having jurisdiction.

I. Where complete concealment is impossible because of obstructions such as beams, ducts, lights, piping, etc., the Contractor shall not install any work before first consulting with the Architect and his instructions (written or revised Drawings) shall be followed.

J. Piping shall be supported from structural steel only, piping shall not be hung from other piping, ducts, conduits, metal deck or from equipment of other trades. Provide necessary structural members, hangers and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc., are supported from concrete construction, care shall be taken not to weaken concrete or penetrate waterproofing.

K. All sprinkler piping shall be installed without being in contact with any other trades. Sprinkler contractor shall coordinate pipe routing with all other trades.

L. All hangers and supports shall be capable of screw adjustment after piping is erected. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted, both in the vertical and horizontal direction.

M. The Architect must approve method of supporting pipes from building structure before work is started. The Contractor shall bear all responsibility for materials and workmanship as described in this Section, and shall make sure that all hangers and supports are properly and permanently connected to building structure.

N. Pipe hangers shall be of the clevis type with threaded rod support. Chains, straps perforated iron or wire hangers are not permitted.

O. Where piping is run near the floor and not hung from the ceiling construction but is supported from the floor, such supports shall be of pipe standards with base flange and adjustable top yoke similar to Anvil Fig. 264 or equal.

P. All piping running on walls shall be supported by means of hanger suspended from heavy angle iron wall brackets. No wall hooks will be permitted.

Q. Lateral bracing of horizontal pipe shall be provided where required to prevent side sway or vibration. The lateral bracing shall be of a type approved by the Architect and shall be installed where directed by the Architect. All piping shall be seismically restrained in accordance with NFPA 13.

R. All anchors shall be separate and independent of all hangers, guides and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work approved by the Architect. Anchors shall be welded to the pipe and fastened to the structure with anchor type bolts.

S. All horizontal steel pipe shall be supported at maximum intervals as follows: Steel pipe - up to 1-1/2" - 12'-0"; 1-1/2" and larger 15'-0". In no case shall a pipe extend more than 12" past a hanger without additional support.

T. Trapeze type hangers shall be made up of angles bolted back-to-back or channels for supporting parallel lines of piping. Trapeze type hangers shall be supported with suspension rods having double nuts, and securely attached to construction with inserts, beam clamps, steel fishplates, cantilever brackets, lag screws or other approved means. Kindorf or other materials typically used for the support of electrical equipment or conduit are not acceptable. Piping supported by trapeze hangers shall be provided with hold down clamps at the trapeze hangers.

U. Maximum weights on hanger rods shall be such that stress in tension shall not exceed 9,000 psi, using root area of threaded portion. In no case shall hanger sizes be less than 3/8" for pipe up to 4", 1/2" for pipe 5", 6" and 8".

V. Supports for vertical piping shall be double bolt riser clamps, with each end having equal bearing on the building structure located at alternate floors but it shall be no more than 25 feet between supports.

W. All hangers, rods, inserts, clamps, stanchions, brackets, etc., shall be dipped in zinc chromate primer before installation and provided with one (1) coat of approved type paint after installation.

X. All pipe supports shall be installed to avoid interference with other piping, hangers, electrical conduits and supports, building structures and equipment.

Y. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products.

Z. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

AA. Painting: Paint all exposed piping. All exposed piping in finished areas shall be painted Red in accordance with building code. All bulk main piping 3 inch and larger shall be identified “SPRINKLER-WATER”.

BB. Piping shall be pitched to drain to inspector test connection or drum drip. Branch piping in dry systems shall be pitched at 1/2” per 10’, mains shall be pitched at ¼” per 10’.

CC. Flushing valves shall be provided on the mains, cross-mains, branch lines and run outs of new sprinklers systems (wet and dry), to facilitate post-construction cleaning and flushing of the system. Valves shall be sized per NFPA 25, in order to obtain the NFPA required minimum velocity of 10ft/s for any given pipe size.

On piping 2” and smaller, line size ball valves can be applied. In mains larger than 2”, typically there is a need for multiple 2” ball valves (especially on 4” and larger mains) to achieve the required flow. The engineer shall use hydraulic calculations to determine the number of 2” valves required on mains larger than 2”.

DD. Global Vision Inc. Zone Check flow switch assemblies (with a key-operated wall switch) are required for all zones. This device allows the annual inspections to be performed without the discharge of system water to drain. Said assemblies shall be exposed and at an elevation (approx. 7’ above finished floor) that allows easy w for maintenance. The key-operated switch shall be installed 48” above finished floor.

EE. Manual inspector’s test and drain valves are also required for zones where Zone Checks are installed.

FF. Threaded fittings are preferred for exposed systems in aesthetically sensitive areas. The use of plain end fittings is discouraged.

GG. All fire service mains shall be controlled by a PIV (post indicator valve) at the building service entrance. All PIVs shall be lockable and supervised by the fire alarm control panel. When selecting the proper location and finish, care should be taken to maintain visibility and 3' of clearance around the PIV for proper operation.

3.3 VALVE INSTALLATION

A. Comply with the following requirements:

1. Install valves except butterfly with stems pointing up, and as close to vertical as possible. Butterfly valves to be offset at least 10° from vertical.
2. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and coordinate location with other trades, walls, etc.
3. Provide drain valves at main shut-off valves, low points of piping and apparatus.
4. Provide separate support where necessary.
5. Furnish all valves as indicated on the plans, or as may be required for the proper control of the pipe lines installed under this Specification. All water valves shall have a minimum working pressure of 175 psi, water rated unless otherwise noted on the Drawings or specified herein. All valves shall be of one manufacturer.
6. All gate valves within the building shall be wedge gate valves with painted iron wheel handles, shall have gland followers in stuffing boxes, and shall be constructed that they may be repacked while open and under pressure. All valves shall have the name of the manufacturer and working pressure cast or stamped thereon.
7. All gate valves 3" and smaller shall be all bronze with brazed or screwed joint ends as required by the piping system in which they are installed.
8. All gate valves 4" and larger shall have iron bodies with bronze mounting except where otherwise required by the authorities having jurisdiction and shall be provided with screwed or flanged ends as required by the piping system in which they are installed. All gate valves controlling equipment shall be of the OS&Y rising stem type except where space conditions do not permit the installation of this type of valve. In such cases non-rising stem valves with indicators shall be provided. \
9. Globe valves shall be of all bronze with composition disc, threaded or brazed joint ends as required by piping system in which they are installed.
10. Drain valves shall be 3/4" heavy cast brass with composition washers with male thread for hose connections.
11. All valves on the exterior fire protection water piping shall comply with Local Fire Department and Water Company requirements.
12. All valves shall have the trademark of the manufacturer and the guaranteed working pressure cast or stamped on the body of the valve. All gates or globes, etc., shall be of one manufacturer and working pressure cast or stamped thereon.
13. All valves used on the fire standpipe and sprinkler systems water service, shall be approved by the Underwriters' Laboratories, Factory Mutual and all the other authorities having jurisdiction. Valves shall be iron body bronze mounted OS&Y solid wedge type valves with rising stems for 175 psi minimum working pressures; iron wheel handles shall be painted red.
14. Tamper switch shall be provided on all fire standpipe and sprinkler valves.
15. The exterior valves shall conform to all applicable requirements of American Water Works Association C500-61 Standard for Gate Valves for Fire Water Work Service.
16. The entire fire protection system shall be supplied with valves so located, arranged and operated as to give a complete regulating control to all fixtures and apparatus
17. Valves, where exposed and used in connection with finished piping, shall be same finish as the pipe.
18. Do not install bronze valves and valve components in direct contact with steel unless bronze and steel are separated by dielectric insulator.
19. Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

20. Select and install valves with renewable seats, except where otherwise indicated.

B. Provide chain wheel operators or ladders for valves more than 7' – 0" AFF in mechanical rooms and wherever shown on drawings.

3.4 CHECK VALVES

A. Check valves up to and including 3" shall be all bronze swing check type with threaded or brazed joint ends. Check valves 4" and larger shall be iron body bronze mounting and shall be provided with screwed or flanged joint ends as required by piping system in which they are installed.

B. Swing Check Valves shall be installed only in horizontal lines unless absolutely impractical. If installed vertically, flow shall be upwards. Do not install in pump discharge piping.

C. Silent Check Valves shall be installed in all pump discharge lines. Silent check valves may be installed in vertical pipes with flow down upon Engineer's review for each instance.

D. Wafer Check Valves shall be installed between 2 flanges in horizontal or vertical position.

E. Horizontal Lift Check Valves shall be installed in horizontal piping line with stem vertically upward.

F. Vertical Lift Check Valves shall be installed in vertical piping line with upward flow with stem vertically upward.

G. Air Compressor Lift Check Valves

H. Spring Loaded Horizontal Lift Check Valves shall be installed in horizontal piping line with stem vertically upward.

3.5 AUTOMATIC FIRE SPRINKLER HEAD INSTALLATION

A. All sprinkler heads shall be in alignment, and parallel to ceiling features, walls, etc. The Contractor shall provide one (1) spare sprinkler cabinet complete with sprinkler wrench and 12 sprinklers of assorted temperature ratings of the type necessary and in use throughout each system at each main riser.

B. Conform to spacing and dimensional constraints indicated by the Architect on the reflected ceiling plans. Sprinkler heads shall be centered within ceiling grid. Where no ceiling grid is provided the heads shall be aligned with any fire alarm device or light fixture in the vicinity. Where the contractor's failure to install sprinkler heads in proper alignment requires the removal, replacement or alteration of ceilings to correct the errors the Sprinkler Contractor shall be responsible for the cutting, patching and restoration of finishes as necessary.

C. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

D. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.6 FIRE STOPS AND PENETRATION SEALS

A. All new piping penetrations through fire rated floors and walls shall be sealed with fire resistant sealant to prevent the spread of smoke, fire, toxic gas, and water through the penetration either before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed.

B. See additional requirements elsewhere in this specification.

3.7 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install check valve and ball drip valve where they will not be subjected to freezing temperatures. The discharge line from the ball drip valve shall be visible. Fire department connections locations shall be easily accessible and a minimum of 18" above grade.

3.8 FIRE HOSE VALVE CABINET INSTALLATION

A. Branch piping to valves must have rigid bracing independent of fire hose cabinet.

3.9 PRESSURE GAUGE INSTALLATION

A. Install pressure gauges at the following locations: street side of check valve; at system side of all control valves. Each gauge connection shall not be less than ¼" and shall be equipped with a shut-off valve and provision for draining.

B. The required pressure gauges shall be 3" diameter minimum and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal, and shall be located where they will not be subject to freezing.

3.10 TAMPER SWITCH INSTALLATION

A. Install tamper switches on all control valves.

3.11 FLOW SWITCH INSTALLATION

A. Install flow switches to properly confirm flow in all system zones.

3.12 FIRE ALARM WIRING

A. All fire alarm and monitor wiring shall be done under the Electrical Division but the proper operation of signaling devices will be the fire protection Contractor's responsibility.

3.13 FLOOR CONTROL VALVE INSTALLATION

A. Floor control valve shall be a complete assembly consisting of an OS&Y valve, grooved butterfly pressure reducing valve (if required), vane type flow switch with retard, inspector's test and main drain valves.

B. Pipe discharge from inspector's test and main drain valves through sight glass and orifice to a drain riser or floor drain.

C. This contractor shall install drain risers to serve floor control valves.

3.14 PIPE TESTING

A. The entire fire protection piping system shall be tested hydrostatically at not less than 200 psi pressure for two hours, or at 50 psi in excess of the maximum static pressure when the maximum static of pressure is in excess of 150lbs. The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested. Each complete system (all associated piping and alarms), shall be tested and accepted as a complete unit, with data recorded on an approved "Contractor's Material and Test Certificate". System pressure tests shall be against a blank test flange and not against a valve seat.

B. All tests shall be conducted in the presence of the Architect and Owner. Any system failing to meet the specified test requirements shall be repaired and retested at no additional cost, until the test requirements are met.

3.15 MAINTENANCE AND OPERATIONAL INSTRUCTIONS

A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system (as built) shall be submitted in a bound book as described in Division 1. The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type maintenance work defined by step-by-step instructions that should be performed to ensure long life and proper operation, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and correction of each. The theory of operation brochures shall describe the function of each component or subassembly in block-diagram type presentation to a degree that a craftsman will understand the system well enough to operate and maintain it.

3.16 PROTECTION

A. Protect all apparatus, fixtures, materials, equipment, and installations so as to prevent damage as a result of new work. The Contractor shall replace at his own expense any item, which is marred, defaced, broken, or damaged in any way, prior to the date of Notice of Acceptance.

3.17 PAINTING

A. Contractor shall paint all exposed new and existing fire protection systems to allow for rapid identification by fire department at all times. New work shall be painted at time of installation; existing systems shall be painted immediately upon exposure to view. Contractor shall continuously update system painting to remain current and accurate at all times. All systems removed from service shall be suitable marked.

3.18 LABELING

A. All piping, valves, devices, etc., shall be labeled in accordance with the requirements of the code, referenced standards, local laws and fire department directives.

3.19 FIELD QUALITY CONTROL

A. All fire protection systems shall be thoroughly cleaned and flushed with tri-sodium phosphate or a cleaning agent approved by Facilities Engineering prior to final acceptance. Once the system is filled by the Contractor, a sample will be taken to verify the concentration of the cleaning agent within the system.

B. A representative of the Environmental Health and Safety shall witness back flushing of all new installations and hydrostatic testing of new sprinkler installations. The authority having jurisdiction (AHJ) requires a representative witness the sprinkler and standpipe hydrostic testing of new installations that are within their jurisdiction. Contractor shall coordinate all testing 2 weeks in advance with both entities.

C. Clean dirt and debris from sprinklers.

D. Remove and replace all sprinklers having any paint on them that is other than the factory finish.

E. Pipe System Cleaning:

1. Clean all pipe lines or sections of lines and connected equipment in new or modified systems and/or flush free of all pipe line debris loosened or introduced as a result of this Contract. This shall include removing all debris that has settled or collected at low points, in equipment, etc. Test equipment used for piping tests may be used to circulate cleaning liquids.
2. Clean and disinfect sprinkler distribution piping as follows:

a. Purge new and reused distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
b. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
c. Fill system with water/tri-sodium phosphate (TSP) solution containing at least 1 gallon TSP liquid per 1000 gallon of system volume, isolate and allow to stand for 24 hours.
d. Drain system of previous solution to sanitary sewer.
e. Flush system with clean, potable water until no TSP remains in water coming from system.
f. Submit water samples in sterile bottles to authorities having jurisdiction.
g. Prepare reports of purging activities.

F. Each system will have a corrosion coupon and test port rack (1" stub with valve and cap) installed at the alarm valve. The corrosion coupons shall be obtained from the FM Pipe Shop Water Treatment Lab so the water quality and corrosion data can be properly recorded and monitored over time as part of ongoing routine maintenance.

G. Upon completion of final cleaning, system shall be treated according to Vassar's Microbiological Influenced Corrosion Control Program. Contractor shall coordinate all requirements with Vassar College.

END OF SECTION

SECTION 21 55 22

ELECTRIC HEATING CABLES FOR FIRE SUPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and Division 26 Materials and Methods, Grounding, and Wires and Cables.

1.2 SUMMARY

A. Furnish and install all electric heating cable systems as specified herein and as required for freeze protection, and heating of piping, valves, fittings, drains, etc., as indicated on the Drawings. Division of work shall be as follows:

1. Plumbing and HVAC Contractors shall provide the heating cables and power distribution panels with alarm breakers, and ground fault protection.
2. The Electrical Contractor shall receive the power distribution panels and heating cables from the plumbing Contractor and install and provide power wiring to the heat trace cables.
3. The Temperature Controls Contractor shall provide and install low voltage wiring to the BMS system and assign alarm points for each panel.

1.3 REFERENCE STANDARDS

A. Each electric heating cable system and all components shall be designed, manufactured and tested in accordance with the latest applicable UL, NEMA, and ANSI Standards as well as NFPA 70 - National Electrical Code (NEC) UL508A.

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

C. All heat trace for standpipe and sprinkler system including branch sprinkler piping in accordance with NFPA14-2013 & NFPA 13-2013. Heat tracing must be Listed for this application.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and shall include, but not be limited to:

1. Electric Heat Tracing System including cables, fittings, thermostats, installation details, circuit capacities, operational details, power distribution panel for group control, etc.

B. Submit Shop Drawings for review prior to installation. Shop Drawings shall show the overall system and each circuit, control locations, cable lengths, current required for each circuit and feed points. Provide a summary sheet of the entire system with capacity data for each line, valve, etc. See Section 26 05 02 for Shop Drawing requirements.

1.5 WARRANTY

A. Provide a Ten (10) year warranty on all cables and devices. Contractor shall complete online warranty form within 30 days from the completion of the installation at https://www.nventthermal.com/application/warranty-10-year/

B. Comply with the requirements of the General Conditions and Section 26 05 02.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. Design Basis: Raychem.
   a. Model: XL-Trace for freeze protection applied between pipe and insulation.
2. Other acceptable manufacturers:
   a. Thermon
   b. Nelson
   c. Chromalox

2.2 ELECTRIC HEAT TRACING SYSTEM FOR WATER PIPING

A. Heat tracing system shall be designed to maintain the water temperature within the piping to at least 40ºF, but not greater that 80 ºF, with an ambient temperature of 0ºF. The piping will be insulated as specified in Division 21 in Section titled “Fire Suppression Insulation”.

B. Heating cables shall be UL listed electrical heating strips. The electric heat tracing may be a self regulating type, radiation cross linked, heater cable with tinned copper braid and modified polyolefin outer jacket suitable for operation on 208 or 277 Volts, 60 hertz, single phase power. The heat tracing strips shall be capable of being cut to the desired length in the field. Operating energy shall be conserved by the self regulating feature of the heater materials, which automatically controls heat output in proportion to the heat requirement.

1. Self regulating at all points along its length.
2. 90% power reduction from 40ºF pipe temperature to 150º pipe temperature.
3. No overheating if crossed.
4. UL listed
5. Ground fault protect shall be provided by the heat trace system controller.
6. Provide tee, splice, and end seal kits as required by the manufacturer.
7. Provide ambient sensing thermostat in a NEMA 4x enclosure, with three (3) contacts rated at 22 amps each.

C. Components shall be Raychem RayClic quick connect type rated for rated 30 AMPS, NEMA 4X enclosures: tees and splices; end seals (silicone gel type); fiberglass tape and electric traced labels; as required. Lighted end seals shall be installed for critical end of line power verification where indicated. All components, except the power connections and any lighted end seals, shall be installed under the thermal insulation.

D. The heat trace cabling shall be controlled by power distribution panels specifically designed and built dedicated for heat trace systems. Panel shall include a 100A main breaker, rated 480 volt 3 phase, 4 wire with 277 volt branch breakers, 12 circuits with ground fault 30 mA trip, NEMA 4 panel with panel front H-O-A switch and status lights. Two sets of contacts shall be wired to the BMS, one to globally engage/disengage the heat tracing system and one alarm output.

2.3 CONTROLS

A. The system shall be field-mounted and shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D when using a solid-state switching device, similar to Raychem DigiTrace C910-485.

B. The system shall provide the user with the option of line-sensing control with a user-selectable dead band, ambient sensing, proportional ambient sensing (PASC), and power limiting control modes.

C. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP) for corrosion resistance and protection from moisture.

D. Each heater cable shall be individually controlled by a line temperature sensing device. The RTD shall be located on each pipe as indicated on the contract drawings. The RTD shall be provided with armored lead wires to prevent damage. Failure of a temperature sensor shall be indicated at the system monitor panel and shall result in activation of the heater cable. Mechanical thermostats shall not be used.

E. Install RTD temperature sensor(s) in worst case location or as indicated by the engineer. The sensor(s) shall be installed in conduit, loose, allowing for future removal & replacement if needed, under the insulation. Extend the conduit a minimum of five (5) feet along the buried piping run and seal the seal both ends. Pipe mounted sensors to be located on opposite side of pipe from heater cable. Avoid installation of temperature sensors near vents, steam lines or other heated locations.

F. The monitor system shall provide UL Listed GFI protection for all branch heater cable circuits per NEC 1996 Section 423-22. GFI shall have a 30 mA trip level. Monitor system shall provide High GFI Current warning at 20 mA.

G. Each heater cable including all tees shall be monitored and provide alarms for high and low current.

H. Fire Suppression System Freeze Protection: Minimum of two (2) RTD temperature sensors shall be employed. An ambient sensing RTD shall energize the heater cables when the ambient air temperature drops to 40 ºF. A second RTD, installed on the smallest pipe in the coldest location, beneath the insulation, shall activate the Low Pipe Temperature alarm at 35 ºF.

I. Freeze protection systems shall activate the Low Pipe Temperature alarm at 35 ºF.

J. Each monitor channel shall have autocycling capability for monitoring cable during the entire year. All setpoints and diagnostics shall be stored in non-volatile memory. Alarms shall be provided for memory and SCR failures.

K. The control system shall provide as standard the following alarm outputs:

L. Dry contact to BMS for common alarm (Low Pipe Temperature, Ground Fault Alarm/Trip, and Loss of Power);

M. DigiTrace units shall be network-ready to provide communication to BMS system, for status review, and alarm annunciation. DigiTrace units shall support the Modbus™ RTU or ASCII/HTCBus communications protocol and be supplied complete with RS-485 communications interface capability.

PART 3 - EXECUTION

3.1 SCOPE AND REQUIREMENTS

A. Furnish and install a complete electric heating cable system, including but not limited to cable, panels, ambient air sensors, aquastats, and controls, on all water piping, fittings, drains, valves, and valve bonnets as indicated on the Drawings. The Electrical Subcontractor shall coordinate the cable installation with the Mechanical and Plumbing Subcontractors. See drawings for scope and locations.

B. All installation and materials furnished shall meet the NEC requirements and be Underwriters Laboratories listed for the application.

C. The installation and all materials, conductors, conduit, etc. utilized between the electric heating cable system, controls and distribution panels shall be as specified.

D. After the piping has been successfully pressure tested, heating cables shall be installed parallel to the pipe or by spiraling the strip to obtain the heating capacity required. All cables and components shall be installed as recommended by the manufacturer by properly trained personnel using the manufacturer specified tools and procedures and as specified herein. The heating cables shall be banded to the pipe with fiberglass tape per manufacturer recommendations. After the piping has been insulated, appropriate caution signs or markings shall be provided at frequent intervals along the pipeline in accordance with NEC requirements.

E. Heat trace cable shall be installed by a licensed electrician. Plumbing contractor shall subcontract this work to a licensed electrician if plumbing contractor is not a licensed electrician.

F. Apply the heat trace cable on the pipe after pressure testing.

1. Do not spiral wrap on pipe.
2. Make one wrap at valves.
3. Secure to pipe with methods approved by manufacturer.

G. Apply “Electrically Traced” signs on outside of insulation.

H. Heat trace shall be sized as follows, based on -20ºF ambient, to maintain 40ºF pipe temperature:

PIPE SIZE	1” INSULATION	2” INSULATION
Less than 2”	3 w/ft.	3 w/ft
2”, 2½”, 3”	5 w/ft	3 w/ft
4”, 5”, 6”	8 w/ft	5 w/ft
8”, 10”, 12”	(2 cable circuits) 8 w/ft ea.	8 w/ft

I. Provide heat tracing on all pipes installed within the building outside water room.

J. Buried piping shall be traced with an extra run of cable provided as an installed spare. Terminate the cable, unpowered, above ground with manufacturer's waterproof end seal.

K. Heat trace all piping installed outside the building.

L. After the piping has been successfully pressure tested, heating cables shall be installed parallel to the pipe or by spiraling the strip to obtain the heating capacity required. All cables and components shall be installed as recommended by the manufacturer by properly trained personnel using the manufacturer specified tools and procedures and as specified herein. The heating cables shall be banded to the pipe with fiberglass tape per manufacturer recommendations. After the piping has been insulated, appropriate caution signs or markings shall be provided at frequent intervals along the pipeline in accordance with NEC requirements.

M. The Electrical Subcontractor shall test all electric heating cable systems for short circuits, grounds and insulation resistance. Test with 1000 VDC to a minimum resistance of 20 mega ohms.

3.2 FIELD TESTING

A. Refer to Section 26 05 03 for additional testing requirements for electric heating cable systems.

3.3 FIELD QUALITY CONTROL, TESTING & WARRANTY

A. The installing contractor shall perform tests in accordance with the manufacturer's Installation an Operation Manual. The installing contractor is responsible for testing runs of cable during installation, at the conclusion of work each day, prior to walls or ceilings being closed. Testing includes resistance testing with a 2500 VDC megohmmeter

(megger) to insure cable integrity, capacitance testing to verify installed length and continuity and visual inspection for damage and conformity to design.

B. Provide as-built diagrams of the tracing installation including locations of all controllers, power connections, tee's, splices, standard and lighted end terminations and circuit identification of breakers with their corresponding piping.

C. The Contractor shall coordinate final system start-up / testing of completed system sections with the Construction Manager, Manufacturer's Representative and the Electrical Contractor. Final testing shall be witnessed by the Construction Manager and Manufacturer's Representative.

D. Submit records of circuit number, circuit length, all test data (final megger and capacitance readings and power drawn per circuit at design temperature), satisfactory completion of final commissioning and record of TEN (10) year warranty extension to the Construction Manager, Owner and representative.

3.4 SOURCE QUALITY CONTROL

A. Obtain material from the Product Manufacturer's Authorized Sales, Service and Warranty Representative.

B. The Representative shall have in his employ a minimum of three (3) factory trained service technicians capable of on-site installation training and troubleshooting. The Representative shall offer service contracts with 24 / 7 / 365 availability and shall maintain a fully staffed service facility with a stock of parts, located within 50 miles of the site. The Representative shall have a proven track record of a minimum of ten (10) years serving the Class A high-rise building, institutional and municipal markets.

END OF SECTION

SECTION 21 90 00

FIRE SUPPRESSION SYSTEM PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Test and balance reports
5. Record drawings
6. Permit requirements
7. Valve tag list

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for life safety systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the fire protection systems.

B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary – Fire Protection

- ☐ All required submittals have been submitted and either been approved or modified in accordance with the Engineer's "make corrections noted" comments.
- ☐ All equipment has been started up and is functioning within manufacturers' recommendations without any undue noise or vibration. (Submit a list of equipment with startup dates. Provide list at a point 65% into construction schedule).
- ☐ Access doors have been installed as required for concealed equipment, valves, etc.
- ☐ All equipment has been installed with the manufacturers recommended and code required service clearances and is fully accessible for required maintenance.
- ☐ All equipment and piping is labeled per specifications.
- ☐ All action items are complete as listed in the action items reports. Submit a list of action items with sign off by Architect or Engineer for record. Punch list to be completed prior to turn over of building.
- ☐ Fire sprinkler system tested per specifications.
- ☐ Operation and maintenance manuals submitted with table of contents and required documentation for extended warranties.
- ☐ Factory Testing documented and submitted for record.
- ☐ Record drawings submitted to Engineer and Architect per specifications.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 TESTING AND ADJUSTMENT FOR FIRE PROTECTION WORK

A. All tests shall be made in the presence of the Architect or their representatives, and the local authorities having jurisdiction of the work to be tested, as may be directed; and at least 72 hours notice shall be given in advance of all tests. Contractor shall perform equivalent test prior to scheduling supervised test.

B. The Work of this Contractor shall include the furnishing of all testing instruments, gauges, pumps, smoke machines, and other equipment required or necessary for tests, required by laws, rules and regulations and as specified.

C. Provide all other tests required by local inspectors and all other authorities having jurisdiction.

D. All appurtenances shall be operated after installation to determine whether or not they meet the requirements of the Specifications.

E. All defects disclosed in the work be tests and otherwise shall be made good or the Work replaced without additional cost to the Owner. No caulking on screwed joints, cracks or holes will be acceptable.

F. Tests shall be repeated after any defects disclosed thereby have been made good or the work replaced if it is deemed necessary.

G. All tests shall be made at the expense of the Contractor.

H. Tests are not permitted to be made with air except as noted.

I. Contractor to provide required test plug tee fittings during erection of pipe system.

J. If the pipe installation fails to meet testing requirements, the Contractor shall determine at his own expense the source or sources of leakage, and he shall repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of the tests after the leaks have been corrected.

K. All piping which is to be enclosed in partitions or hung ceilings shall be tested and made tight when directed by the Construction Supervisor and in adequate time to permit the installation of partitions and ceilings. When necessary, the Contractor shall drain the piping and/or take precautions as required to prevent damage by freezing.

L. The Contractor shall also be responsible for the Work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his Work, and he shall, without extra charges, restore to its original condition any Work so damaged or disturbed.

M. Before any paint is applied, the fire standpipe system shall be tested hydrostatically at not less than 200 psi pressure for two (2) hours minimum, and in accordance with all requirements of the authorities having jurisdiction and NFPA latest edition.

N. Any fees charged by the Fire Department for false alarms attributed to the construction of the fire suppression system will be the responsibility of the Contractor until such defects are corrected and false alarms due to system installation no longer occur.

3.3 LIFE SAFETY SYSTEMS

A. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.

B. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official Once tested by the contractor and fully operational, the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.4 COORDINATION WITH OTHERS

A. The Division 21 through 23 Contractor shall coordinate his requirements with the General Contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 21 through 23 systems.

3.5 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

DIVISION 22
PLUMBING

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 – GENERAL

1.1 REFER TO RELATED SECTIONS

A. Section 23 05 01 – Mechanical and Electrical Coordination
Section 23 05 02 – Basic Mechanical Requirements
Section 23 05 03 – Basic Mechanical Material and Methods

1.2 DESCRIPTION OF WORK

A. Except as otherwise specified under "Related work Not Included", the work of this Contract consists of furnishing all labor, materials, equipment and appliances necessary and required to completely do all Plumbing Work as indicated on the Drawings or described or referred to in the Specifications, including, but not limited to the following:

1. Complete exterior sanitary sewer system up to and connecting to the site civil work. Coordinate connection with Civil drawings.
2. Complete exterior domestic and fire protection water services, curb valves, etc. up to the site civil work. Coordinate connection point with Civil drawings
3. Exterior storm drainage piping, including drain inlets, frames, covers, grates, etc. up to the site civil work. Coordinate connection point with Civil drawings.
4. Complete interior storm water drainage systems with leaders, roof and area drains, and piping system conveying storm water drainage to site storm drainage system.
5. Complete interior sanitary, soil, waste and vent piping systems, including all required connections to all plumbing fixtures and equipment, house sewer, and connections to the site sanitary sewer system.
6. Complete interior domestic cold water system including connections to the site water system piping, cross connection control devices, remote readouts for water meter, and connection to all fixtures and equipment requiring cold water.
7. Complete interior domestic hot water distribution systems including connections to all fixtures and equipment requiring hot water, connections to hot water supply and hot water circulation systems, new hot water heaters and circulation pumps.
8. Plumbing fixtures and trim for same.
9. Furnishing of access doors for installation under another Division or Section of these Specifications.
10. Excavation and backfill for all work herein specified.
11. Make all plumbing connections required for equipment furnished under other Divisions or Sections of these Specifications.
12. Hose bibbs, wall hydrants, shock absorbers, vacuum breakers and backflow preventers.
13. Sleeves, hanger and supports.
14. Insulation for piping and equipment.
15. Apply for and obtain and pay for all permits, certificates, inspections and approvals required in connection with all Plumbing Work.
16. Shop drawings, samples and instructional manuals, tests and adjustments.
17. Installation of all fixtures furnished by Owner and/or furnished under other Divisions or Sections of the Specifications.
18. Provide roughing (water supplies, soil, waste, and vent piping) for all fixtures and equipment furnished and/or installed under other Divisions or Sections of these Specifications.
19. Sump pump assemblies.
20. All interlocking control wiring and conduit.
21. Concrete pads for pumps and equipment.
22. Color coding and stenciling of all piping systems.
23. Cutting and rough patching.

24. Cap flashing and prime painting.
25. Tests for all systems provided under this Section.
26. Where due to Union regulations or trade agreements, any of the work shown on the Drawings or specified herein is not considered Plumber's Work, this Contractor shall subcontract the work in question, but this Contractor shall be held responsible for the complete installation.
27. It is not the intention of these Specifications to describe nor the Contract Drawings to show in detail, all the various pieces of apparatus and appurtenances and their connections. This Contractor shall, as part of the Contract, furnish and install all incidentals, such as pipe, fittings, valves, etc., required to complete the installation of the equipment. This Contractor shall refer to Architectural Drawings and Plumbing Drawings for exact location of fixtures including type and quantities. This Contractor shall be responsible for providing isolation valves in locations suitable to isolate equipment, risers, building sections, etc. This Contractor shall be responsible for providing and connecting all fixtures and equipment.
28. All work described in the Specifications and not shown on the Drawings, or vice versa, shall be installed in a manner similar to the work shown or described.
29. Plumbing Contractor shall provide temporary water service on the site to the locations indicated by the Construction Manager, on the site temporary fire protection water, all in accordance with requirements of the state and local codes, the Water Company and the Fire Department. Plumbing Contractor to pay all fees and obtain all permits required in connection with the water services.
30. Prepare and submit to the Engineer, all drawings, applications, test reports, correspondence, etc., as required in connection with the approval and installation of the backflow preventors and/or double check valves, as indicated on the Drawings or as required by the New York State Department of Health. Contractor shop drawings shall be suitable for filing with authority approving the installation. Engineer shall sign and seal as Engineer of Record.

1.3 RELATED WORK NOT INCLUDED

A. The following principal items of work shall be provided under other Sections; the General Contractor shall be responsible for coordinating the purchase of this work from other trades:

1. Finish painting.
2. Furnishing of toilet room accessories.
3. Installation of access doors. This Contractor shall furnish access doors.
4. Kitchen equipment, including hoods and fire protection system for same, booster heaters and trim.
5. Base flashing for roof drains, and piping passing through roofs.
6. All electrical power wiring conduits, etc., for pumps, equipment, etc., shall be provided under Division 26.
7. Drainage piping from HVAC equipment to and spilling over floor drain, mop sink, sump or roof, except as noted.
8. Temporary toilets and water supply.
9. Finish patching.
10. Sheet metal gutters and leaders.

1.4 VISITING THE PREMISES

A. This Contractor, before submitting his bid on the work, shall visit the site and familiarize himself with all visible existing conditions. As a result of having visited the premises, this Contractor shall be responsible for the installation of the work as it relates to such visible existing conditions.

B. The submission of a bid will be considered as acknowledgment on the part of the bidder of his visitation to the site.

1.5 QUALITY ASSURANCE

A. Manufacturer's Instructions

1. In addition to the requirements of these Specifications, comply with the manufacturer's instructions and recommendations for all phases of the work.

B. Standards and Codes
Comply with the latest editions of the following:

Building Code of New York State
New York State Plumbing Code.
National Fire Codes (N.F.P.A.)
Local Gas Utility Rules and Regulations.
Local Municipal Rules and Regulations.
Local Fire Department requirements.
Local Water Company Rules and Regulations.
Other State and Local Authorities having jurisdiction.
F.M. and/or F.I.A. regulations.

C. All work and material not specifically described, but required for a complete and proper installation of the work of this Section, shall be provided by the Contractor and shall be new, first quality of their respective kinds, and subject to approval of the Architect.

D. All water supply connections to plumbing fixtures and other equipment to be installed under this Division shall be in accordance with the rules relative to submerged inlets and protective methods to be applied to prevent contamination of water as required by Local and State Regulations.

E. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

F. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

G. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

H. All piping shall be domestically manufactured and shall be by the same manufacturer.

I. All work shall be done by a licensed Plumbing Contractor.

1.6 CONCRETE WORK

A. All concrete equipment bases that are installed on vibration isolators, all anchor and thrust blocks and all piping supports in trenches shall be provided under the work of this Section. All formed and poured-in-place concrete work including equipment housekeeping pads, sumps, etc., will be provided under another Division or Sections of these Specifications. The General Contractor shall be responsible for coordinating the purchase of this work from other trades.

B. This Contractor shall furnish all required templates for anchor bolts, and dimension drawings for housekeeping pads and sumps. All concrete provided under the work of this Section shall be in accordance with that specified under other Division or Sections of these Specifications. The General Contractor shall be responsible for coordinating the purchase of this work from other trades.

1.7 REPLACEMENT OF SURFACING

A. Where required by operations under this Section, the Contractor shall remove and replace all damaged street pavements, curbs, sidewalks, walkways, grassed areas and landscaped areas which are to remain, in a manner equal to their original condition when new.

B. In those cases where final surfaces cannot be placed immediately, a temporary surfacing of two inches of bituminous concrete shall be placed and maintained. This shall be removed before placement of final surfacing.

C. Landscaping and grassed areas shall be preserved and/or replaced to the satisfaction of the Architect.

D. See additional requirements elsewhere in this specification.

1.8 COOPERATION WITH OTHERS

A. The Plumbing Contractor shall cooperate with other trades whose work is to be correlated with his work, in order to avoid field interference, improper elevations, or inaccessible work. Any extra expense occasioned by lack of cooperation by this Contractor shall be borne by him.

1.9 GREEN BUILDING REQUIREMENTS AND PERFORMANCE CRITERIA

A. Green Building Performance Criteria:

1. All field-applied concrete admixtures, adhesives, sealants, paints and coatings used for interior applications shall meet the volatile organic compound (VOC) and chemical component limitations as defined by EPA and USGBC.

B. Green Building Submittal Requirements:

The Contractor and their sub-contractors shall submit the GREEN BUILDING CERTIFICATION items listed herein.

1. GBMCF: Submit a completed GREEN BUILDING MATERIALS CERTIFICATION FORM. Information to be supplied for this form shall include:

    a. Cost breakdowns for the materials included in the Contractor or sub-contractor's work. Cost breakdowns shall include total cost plus itemized material costs for and VOC containing products.
2. Validation: Published product literature or manufacturer's letter of certification (on the manufacturer's letterhead) validating all information, other than costs, provided in the GBMCF.
3. Cut Sheets: Product cut sheets for materials listed in the GBMCF. Cut sheets shall be submitted with the Contractor or Trade Contractor's stamp, confirming that the submitted products are the products installed in the Project.
4. VOC Content: Material Safety Data Sheets (MSDS), published product literature, or manufacturer's signed certification (on manufacturer's letterhead) stating the VOC content of all applicable products.
5. Submittal Package: The GREEN BUILDING submittal information shall be assembled into one (1) package per Section or trade, and sent to the Consultant for review. Incomplete or inaccurate Green Building submittals may be used as the basis for rejecting the submitted products or assemblies.

PART 2 – NOT USED

PART 3 – NOT USED

END OF SECTION

SECTION 22 05 13

PLUMBING MOTORS AND STARTERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data.

1. Motors: Identify by unit served. Include:
   a. Voltage
   b. Phase
   c. Horsepower
   d. Frame
   e. Insulating class
   f. Efficiency
   g. Power factor
   h. Index number
   i. Speed
   j. Starting characteristics
2. Starters: Identify by motor served. Include:
   a. Enclosure, NEMA Type
   b. NEMA size
   c. Accessories, switches, transformers, etc.
   d. Wiring diagram
   e. Auxiliary contacts
   f. Thermal overload size
3. Submit as part of packaged unit submittals when purchased as part of item of equipment.

1.2 SINGLE MANUFACTURER

A. Provide all motors, except those factory mounted, by a single manufacturer.

B. Provide all starters, except those factory mounted, by a single manufacturer.

C. "Factory mounted" means "as part of a packaged unit" where the motor is not purchased separately from the driven equipment.

PART 2 - PRODUCTS

2.1 MOTORS (OTHER THAN FACTORY MOUNTED)

A. Manufacturers:

1. Design Basis: Reliable
2. Other Acceptable Manufacturers:
   a. General Electric
   b. Westinghouse
   c. U.S. Motor
3. Factory mounted motors may be by equipment manufacturer's standard supplier.

B. Bearings: Ball bearings, grease lubricated with grease fittings.

C. Enclosure: As required by location.

D. Service Factor: 1.15.

E. Full-Load Operation: At 105ºF and altitude of project.

F. Insulation:

1. Constant Speed: Class B.
2. Variable Frequency Controlled: Class F.

G. Efficiency Ratings:

1. All motors one horsepower and larger, except as noted, shall be premium efficiency motors, in accordance with NEMA Standard MGI-2003 (Tables 12-12 and 12-13) and New York State Energy Code.

H. Electrical Characteristics:

1. Refer to sections 23 05 01, Mechanical and Electrical Coordination.
2. Motors ½ hp and smaller shall be 115-volt single phase.
3. Motors ¾ hp and larger shall be three phase, of voltage shown in Electrical Section of Contract Documents.

I. Multi-speed Motors:

1. Motors may be one or two winding, 1800/900 RPM.

J. Variable Speed Drives:

1. All motors operated by a variable speed drive shall be rated for inverter duty.
2. Motor insulation shall be rated for 1600-volt peak.
3. All motors shall be NEMA MG-1, Part 31 compliant.
4. See additional requirements elsewhere in this specification.

2.2 MOTORS (FACTORY MOUNTED)

A. Provide premium efficiency motors.

2.3 VARIABLE FREQUENCY DRIVES

A. All motors operated by a variable speed drive shall be rated for inverter duty. Motor insulation shall be rated for 1600 volt peak.

B. All motors shall be NEMA MG-1, Part 31 compliant.

C. See additional requirements elsewhere in this specification.

2.4 STARTERS

A. Manufacturers:

1. Allen Bradley
2. Cutler-Hammer
3. General Electric
4. Square D

B. General:

1. Starters shall be standard NEMA sizes and UL listed.

C. Type: Across the line except where noted.

D. Enclosure: NEMA Type as required for location. Provide stainless steel enclosures in wash down areas, kitchens, dishwasher areas, exterior spaces, and any other areas where equipment will be exposed to moisture. Provide space heater and any necessary transformer within the enclosure as required to maintain the minimum internal temperature required by the manufacturer.

E. Overload Protection:

1. Type: Trip-free thermal overload relay.
2. Location: Each ungrounded conductor.
3. Reset: Manual.
4. Ambient Temperature Compensation: Provide where required.
5. Overload protection to be sized for nameplate running amps.

F. Auxiliary Contacts:

1. Provisions to add three without removing starter from enclosure.
2. Number: Provide three per starter as required for control sequence, and one (1) auxiliary contact.
3. Switchable type, easily changed from N.O. to N.C. without removing from its mounting.

G. Switches in Cover:

1. Manually Controlled: Three wire start-stop.
2. Automatically Controlled: Hand-off-automatic.
3. Start and stop indicating lights.
4. Equipment not designed to run continuously: Off-Automatic.

H. Control Transformer:

1. Provide when line voltage exceeds 208 volts.
2. Secondary wiring shall have one leg fused and the other grounded.
3. Secondary voltage not to exceed 120 volts.

I. Provide starters for all motors as follows:

1. Single phase motors less than ½ hp.
   a. With internal overload protection: None.
   b. Without internal overload protection:
      1) Manually Controlled: Manual starter.
      2) Automatically Controlled: Magnetic starter.
2. Single phase motors ½ hp and larger:

a. Manually Controlled: Manual starter.
b. Automatically Controlled: Magnetic starter.

3. Three Phase Motors: Magnetic starter.

J. Soft Start Starters:

1. Provide Y-Delta or solid state reduced voltage starters for all motors 50hp and larger.
2. Starter shall limit starting voltage to 200% of full load voltage.

K. Multi-Speed Starters:

1. Starters shall be suitable for the type multi-speed motor selected.
2. Provide time delay for automatic transfer from high to low speed.

L. Disconnecting Means:

1. All starters provided shall be combination starter-disconnect type unless specifically stated otherwise on drawings.

PART 3 - EXECUTION

3.1 MOTORS

A. Install motors on motor mounting systems so coupling or belt drive is properly aligned. Provide proper belt tension. Dowel direct coupled motors.

3.2 STARTERS

A. Deliver to installer of electrical work.

B. All safety devices shall be wired so that they will stop the motor with a hand-off-automatic switch in the hand as well as the automatic position.

END OF SECTION

SECTION 22 05 23

PLUMBING VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's product data including:

1. Dimensions
2. Sizes
3. End Connections
4. Weights
5. Installation instructions
6. Instructions on repacking and repairing valves.
7. Range of flow for balancing valves and plug valves.
8. Pressure reducing valves.
9. Backflow preventors.
10. Backwater valves.
11. All other applicable valves.

B. Valve Tag List: Refer to Section 22 05 53 of the Specifications.

PART 2 – PRODUCTS

2.1 GENERAL

A. Where type or body material is not indicated, provide valve with pressure class selected from MSS or ANSI standards, based on the maximum pressure and temperature in the piping system.

B. Except for balancing or when otherwise indicated, provide valve of same size as connecting pipe size.

C. Unless specifically required by note or symbol, all water valves shall be ball valves. If ball, butterfly, globe, plug, or balancing valves are called out by note or symbol, only that type of valve is acceptable.

D. Butterfly valves may be used for valves larger than 6" in non-balancing applications when pressure and temperature ratings are adequate.

E. Where pipe sizes overlap, contractor has the option of threaded or flanged valves.

F. Where grooved pipe mechanical coupling systems are accepted, provide flange adapters to mate with valves as specified below. Valves manufactured by the mechanical coupling system manufacturer shall not be used unless they meet all of the specified requirements for a given valve.

G. All valves shall be domestically manufactured.

H. Valves used for domestic water service shall be bronze or stainless steel. Iron and brass body valves are not acceptable. Comply with NSF-61 for lead free potable water piping.

I. All valves shall be of a design which the manufacturer lists for the service and shall be of materials allowed by the latest edition of the ASME Code for pressure piping for the pressure and temperature contemplated, unless a higher grade or quality is herein specified.

J. Valve packing compression is to be independent of the stem, ball or handle systems. All valve stems are to be blowout proof. Packing shall be accessible without disturbing the insulation.

K. Plug or gate valves shall not be used on any services without approval by the Vassar Department of Planning, Design and Construction.

L. All valves used for vent or drain services on water systems shall have a brass hose connection with cap and chain.

2.2 GLOBE VALVES

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
   a. Viega
   b. Crane
   c. Nibco
   d. Powell
   e. Gruvlok
   f. Stockham
   g. Hammond

B. Globe valves shall be of all bronze with composition disc, threaded, propress, or brazed joint ends as required by piping system in which they are installed.

C. All iron valves in potable water systems shall be NSF 61 listed and FDA approved epoxy coated cast iron valve bodies with bronze seats

D. Except where otherwise noted, all valves for use with copper tubing shall be as follows:

2" AND SMALLER	UNDER 200 PSI	Milwaukee Model 1502 Bronze, 125 PSI SWP, 200 PSI WOG, Rising Stem, Screw Bonnet, Bronze Disk, MSS SP-80, Type 1, Solder Ends. Milwaukee Model 502 for Threaded Ends.
2 ½" AND LARGER	UNDER 200 PSI	Milwaukee Model F-2981 Iron, 125 SWP, 200 WOG, Non-Shock, Solid Disc, Bolted Bonnet, Gland Packed, Flanged Ends

2.3 ANGLE VALVES

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
   a. Viega

b. Crane
c. Nibco
d. Stockham
e. Hammond
f. Gruvlok

2" AND SMALLER	UNDER 300 PSI	Milwaukee Model 595T Bronze Body, 150 WSP, 300 WOG, Threaded, Union Bonnet, Angle Bronze Disc, with Solder Joint Adapter.
2" AND SMALLER	UNDER 200 PSI	Milwaukee Model 504 Bronze Body, 125 PSI, SWP, 200 PSI WOG, Bronze Disc, Threaded Bonnet, with Solder Joint Adapter.

2.4 SWING CHECK VALVES

A. Manufacturers:

1. Design Basis: Nibco
2. Other Acceptable Manufacturers;
   a. Viega
   b. Crane
   c. Milwaukee
   d. Powell
   e. Stockham
   f. Victaulic (for Grooved Pipe Systems)
   g. Gruvlok
   h. Hammond

B. Check valves up to and including 2" shall be all bronze swing check type with threaded, propress, or brazed joint ends.

C. For domestic water use up to 2" piping: Horizontal swing, regrinding type ASTM B 584 Alloy C87850 body, 200 PSI CWP, Y Pattern, Renewable PTFE Seat and Disc, MSS-SP-80, NSF-61 for potable water.

1. Model: T-413-Y-LF

2.5 SILENT/WAFER CHECK VALVES

A. Manufacturers:

1. Design Basis: Milwaukee

2. Other Acceptable Manufacturers:
   a. Viega
   b. Metra Flex
   c. Hammond
   d. Nibco
   e. Tyco
   f. Gruvlok
   g. Stockham

2" AND SMALLER	UNDER 200 PSI @ 250 °F	Milwaukee Model 548T Bronze Body and Trim, Center Guided, Single Disc, 250 PSI Rating.
2½" AND LARGER	UNDER 200 PSI @ 150 °F	Milwaukee Model 8800 Iron body, Stainless Steel Trim, Center Guided Double Disc, 200 PSI Rating.

B. All iron valves in potable water systems shall be NSF 61 listed and FDA approved epoxy coated cast iron valve bodies with bronze seats

C. Where application or building height causes working pressure to exceed 125 psi, provide silent check valves 3" & up: Milwaukee 1800, 250 lb. WSP, semi-steel.

D. Double disc or bi-folding disc type valves are not acceptable.

2.6 BUTTERFLY VALVES

A. Manufacturers:
1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
   a. Viega
   b. Crane
   c. Keystone
   d. Nibco
   e. Victaulic (for Grooved Pipe Systems)
   f. Hammond Watts
   g. Bray
   h. Gruvlok
   i. Stockham

B. All iron valves in potable water systems shall be NSF 61 listed and FDA approved epoxy coated cast iron valve bodies with bronze seats

C. Hydronic Service (less than 250ºF): 200 psi WOG, cast or ductile iron fully lugged body, integral extended neck to clear insulation, integral top plate for actuator mounting, stainless steel stem, upper and lower lubricated bushings, field replaceable hard back seat with integral stem and flange seals, machined disk seating areas, rated for minimum 200 psi dead end service with no downstream flange. Liner to be compatible with operating fluid. Conform to MSS-SP67.

1. Model: Figure CL223E.

D. Provide 10 position locking lever handler for valves 6" and smaller. Infinite position memory stop lever handle for all valves 6" and smaller used for balancing. Chain wheel operator where required.

E. Butterfly valves in size 2½" - 12" shall be of the flanged body style. All valves shall be suitable for use with ANSI 125 or 150 pound flanges. Bodies shall be cast. Valves shall be rated at 200 psi and provide drip-tight shutoff at differentials up to 200 psi. Bodies of all flangeless wafer valves shall have 4 flange bolt guides to center the body in the pipeline. Size ½" – 2", use ball valve.

F. Lug body valves shall have a retained seat and shall provide tight shutoff up to the full valve rating on dead end or isolation service without the use of downstream flanges.

G. Bearings shall be self-lubricated TFE coated stainless steel. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.

H. Seats shall be of material suitable for use with potable water. Seats shall be of the reinforced resilient type and shall be field replaceable and shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without use of flange gaskets.

I. Shafts shall be one piece and shall be of 416 stainless steel. Shafts shall be finish ground to minimize bearing and shaft seal wear. Operating shaft to be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings.

J. Discs shall be aluminum bronze. The disc-to-shaft connections shall be type 316 stainless steel. Pins, shaft and disc of all valves shall be individually machined and completely interchangeable.

K. Latch lock levers shall provide automatic, positive latching in the open, closed or eight intermediate positions. These valves shall allow locking in any position with a standard padlock. Infinite position levers shall allow manual throttling and locking in any position from open to close. External disc position indicators shall be provided.

L. All manually actuated valves 8" and larger shall be operated using a cast iron housed handwheel actuator available in standard, weatherproof, or buriable constructions (as required) with optional chain wheel, crank, or 2" square nut input. All units to have adjustable open and closed position stops with provision to prevent accidental adjustment changes.

M. Provide valves rated for elevated pressure where operating pressures exceeds 125 psi.

N. Grooved end steel pipe butterfly valves 2” through 12” shall be ductile iron, nickel-plated ductile iron disc, type 416 stainless steel two-piece stem, disc shall be offset from the stem centerline to provide continuous 360 degree seating, EPDM seat and seal material. Valve shall have a lever handle or gear operator with handwheel. Valve shall be suitable for bubble tight shutoff, dead-end and bi-directional service at 300 psi full rated pressure. Victaulic Vic-300 MasterSeal™.

2.7 BALL VALVES

A. Manufacturers:

1. Design Basis: Nibco
2. Other Acceptable Manufacturers:
   a. Viega
   b. Apollo
   c. Dyna Quip
   d. Hammond
   e. Milwaukee
   f. Watts
   g. Gruvlok
   h. Stockham

B. Cast bronze, 150, SWP, 600 WOG (min), ASTM B283 Alloy C69300 ball, two piece design, blow-out proof stem, adjustable packing gland nut (allowing handle to be removed without leaking) TFE seats, MSS-SP-110, NSF-61 for potable water.

1. Model: T-685-80-LF - full.port.

C. Provide the following where required:

1. Extended stems for insulated valves.
2. Memory stop device for balancing applications.
3. Tee handle for tighter areas.
4. Hose end and cap for drain.
5. Mounting pads for actuator.
6. Provide “stop and drain” for compressed air.
7. Ball Valves up to 2” may be used for all water services, globe valves and balancing cocks.
8. Ball valves shall be bronze body, 316 stainless steel ball and stem, Teflon seats and seals threaded ends, 400 psig cold W.O.G. Worchester No. 411T-SE or equal.

A. Minimum flow coefficients (Cv):

Size	Cv
½”	8
¾”	14
1”	35
1¼”	46
1½”	75
2”	105
2½”	300
3”	390
4”	680

2.8 CIRCUIT SETTERS (CS)

A. Manufacturers:

1. Design Basis: Bell & Gossett Circuit Setter Plus

2. Acceptable Manufacturers:
   a. Viega
   b. Taco

B. Valves ½” to 3”:
1. Valve body shall be constructed out of lead free brass
2. Valve shall include a ball valve constructed in 304 Stainless Steel.
3. Valve shall be AB1953 and CSA certified and compliant with Vermont 152S, Maryland House Bill HB372, Senate Bill S.3874, and NSF/ANSI-372.
4. Valve body shall include two pressure/temperature ports.
5. Valve body shall include a drain valve port.
6. Valve shall utilize a calibrated nameplate with a memory stop.
7. Valve shall utilize a reduced port design that provides velocity head recovery.
8. Valve temperature range shall be from -4°F (-20°C) to 250°F (121°C)

C. Valves ½” to 2” pipe size, NPT, sweat, or press-fit.
D. Valves 2 ½’ and 3” pipe size, NPT, flanged, or grooved.

2.9 DOMESTIC WATER PRESSURE REDUCING VALVE

A. Manufacturer (2½” and smaller):

1. Design Basis: Watts Model 223S
2. Other Acceptable Manufacturers:

a. Febco
b. Wilkins

3. Construction:
   a. Seal: Renewable, stainless steel.
   b. Strainer: Stainless steel.
   c. Diaphragm: High temperature resistant.

B. Manufacturer (3" and larger):

1. Design Basis: Watts Model: ACY 115-2 (3" through 12")
2. Other Acceptable Manufacturers:
   a. Febco
   b. Wilkins
3. Construction: "Quadseal", non-edged seat, 100% fused epoxy finish, stainless steel seats through 8", FDA approved diaphragm.

C. The valve shall maintain a constant downstream pressure regardless of varying inlet pressure. This valve shall be a hydraulically operated diaphragm-actuated, angle pattern valve. It shall contain a resilient synthetic rubber disc, having a rectangular cross-section, contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert.

D. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. This diaphragm assembly shall be in the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from the line pressure.

E. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the valve or pilot controls. All necessary repairs shall be possible without removing valve from the line.

F. The pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The control system pressure is less than the spring setting. The control system shall include a fixed orifice.

2.10 EXTERIOR WATER SERVICE VALVES

A. Furnish and install all underground control valves and valve boxes for water service and branches as indicated on the Drawings.

B. All gate valves shall be similar and equal to Stockham G743-0 N.R.S. iron body, bronze mounted, double disc, parallel seat, mechanical joint, with operating nut. Valves shall be open left. Other manufacturer will be accepted when required by Local Authorities.

C. All valves shall be installed complete with concrete supporting pads and valve boxes and valve covers. All of the foregoing shall be included in the price of valves. Valve boxes shall be set so the tops are flush with proposed finished grade. They shall be reset if required to meet finished paving or grade.

D. All valve boxes, top and bottom sections and covers shall be manufactured by "Kennedy," Fig. 121 as specified for the fire service coated with coal tar pitch varnish and word "WATER" cast on cover.

E. The deep box type yard hydrants shall be cast brass non-freeze with ¾ inch hose connection, vacuum breaker and a bleed-off connection on valve body to drain the casing, for 5'-0" bury, as manufactured by J.R. Smith Fig. No. 5810-VB, MIFAB #HY 6800-8, or equal. At least six (6) cubic feet of crushed stone (French drain) shall be provided at the drip valve.

2.11 LOCAL EQUIPMENT AND FIXTURE PRESSURE REGULATORS

A. Furnish and install a CASH-ACME type HER or approved equal water pressure reducing valve on all cold and hot water branch lines for food service laboratory and medical equipment as provided under other Division of Sections of this Specification. Pressure reducing valves shall be of the differential type, self-contained, single seated, direct acting, spring locked type with no diaphragm. Valve body and spring housing shall be bronze and all other parts shall have a corrosion resistance equal to bronze.

B. All valves shall be sealed against leakage including a top cap over the adjusting screw.

C. Internal parts subject to wear shall be replaceable without removing valve from the pipe line, valve shall be provided with means to adjust outlet pressure setting.

D. Valves shall have sufficient water capacities to provide required rates of flow and shall be set at discharge pressure as required by the point of use.

2.12 BACKFLOW PREVENTER

A. Backflow Preventer, Reduced Pressure Zone Type, Food Service Applications

1. Design Basis: Watts No.SS009QT Series
2. Other Acceptable Manufacturers:
   a. Febco
   b. Wilkins
3. Construction: Stainless steel trim and body, complete with test cocks, resilient seat, shut-off valves, and air gap fitting.
4. Complies with ASSE STD 1013

B. Backflow Preventer, Reduced Pressure Zone Type (Domestic Water Service, Irrigation System Connection)

1. Manufacturer:
   a. Design Basis: Watts No. LF909, (1/2" through 10") unless otherwise specified on the drawings.
   b. Construction: Bronze body, stainless steel trim, complete with test cocks, resilient seat, shut-off valves, and air gap fitting.
   c. Other Acceptable Manufacturers:
      1) Beeco
      2) Febco
      3) Wilkins
2. Complies with ASSE STD 1013.

3. The reduced pressure backflow preventer shall consist of two separately spring loaded "Y" type check valves and one differential relief valve having two diaphragms separated by a spacer. This device shall automatically reduce the pressure in the "zone" between the check valves. Should the pressure differential, normally 4.5 psi, drop to 3.0 psi, the relief valve shall open, dumping the liquid to atmosphere and maintain the proper differential. A small hose in the spacer will bleed to atmosphere if either diaphragm is damaged, giving visual evidence of diaphragm failure. Both check valves shall be serviceable without removing the device from the line. RPZ shall be rated to 150 psi working pressure and 212°F water temperature. Backflow preventers 2" and smaller shall have bronze bodies and bronze trim. 2-1/2" and larger shall have cast iron bodies with epoxy coating and bronze trim. Backflow preventers shall be similar to Watts 900 or approved equal.

4. Vertical assemblies (Z- or N-pattern) shall only be used where space limitations do not allow for a horizontal assembly. Vertical assemblies shall be similar to Febco LF880V or approved equal.

5. Backflow preventer shall be NSF-61 listed and FDA approved.

C. Backflow Preventers – Double check detector assembly for fire protection service and domestic water Service:

1. Manufacturer:
   a. Design Basis: Watts No 709DCDA unless otherwise specified on the drawings.
   b. Construction: Epoxy coated cast iron body, replaceable bronze seats.
   c. Other Acceptable Manufacturers:
      1) Beeco
      2) Febco
      3) Wilkins
2. Complies with ASSE STD 1048.
3. Where used in potable water system, preventer shall be NSF-61 listed and FDA approved.

D. Backflow Preventer (Atmospheric Vacuum Breaker)

1. Manufacturer:
   a. Design Basis: Watts No. 008 Series (3/8" through1")
   b. Construction: Bronze body, ball valve shut offs.
   c. Other Acceptable Manufacturers:
      1) Beeco
      2) Febco
      3) Wilkins
2. Complies with ASSE STD 1020.
3. Provide vacuum breakers on water supply piping to each fixture and equipment with submerged inlets, and on faucets and outlets, within the building, to which hose can be, or is attached, forming a submerged inlet. Set vacuum breakers in exposed readily accessible locations and at least 6'-6" above finished floor. Vacuum breakers shall be chrome plated brass, T&S Brass No. B-929-A watts 008 or approved equal. Vacuum breakers shall comply with ASSE STD 2010.

2.13 BACKWATER VALVE

A. Provide backwater valve where indicated on the Drawings.

B. Backwater valve shall be similar to Zurn No. 1095-6 or MIFAB BV 1000, cast iron, hub inlet and offset spigot outlet, cast iron cleanout and plug for caulking into top hub of cleanout opening, automatic type bronze valve seat and flapper which hangs open during periods of non-operation.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with the following requirements:

1. Install valves except butterfly with stems pointing up, and as close to vertical as possible. Butterfly valves to be offset at least 10° from vertical.
2. Install valves at each piece of equipment, fixture or appliance so that the supply and return services can be shut off to remove the item without draining the remainder of the piping system.
3. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Install isolation valves at each concession, bathroom group and riser. Locate valves so as to be accessible.
4. Combination balancing and shut-off valves may be used instead of a separate balancing valve and shut-off valve if the valve has a memory stop and the manufacturer lists its use as a leak-proof service valve.
5. Provide drain valves at main shut-off valves, low points of piping and apparatus.
6. Provide separate support where necessary.
7. Do not allow meter connections of balancing valves to point downward.

8. Install valves so bypass valves are accessible.
9. Furnish all valves as indicated on the plans, or as may be required for the proper control of the pipe lines installed under this Specification, so that any fixture, line or piece of apparatus may be cut out for repair without interference or interruption of the service to the rest of the Building. All water valves shall have a minimum working pressure of 125 psi, water rated unless otherwise noted on the Drawings or specified herein. All valves shall be of one manufacture. Provide valves with elevated pressure rating matched to service conditions where pressure exceeds 125 psi..
10. Drain valves shall be 3/4" heavy cast brass with composition washers with male thread for hose connections.
11. Provide at the high point of hot water piping system a 1/2" automatic IBBM air relief valve, 125 PSI, WOG Class. Pipe drain to spill over adjacent floor drain or service sink.
12. All valves on the exterior domestic and fire protection water piping shall comply with Local Water Company.
13. All valves shall have the trademark of the manufacturer and the guaranteed working pressure cast or stamped on the body of the valve. All globes, etc., shall be of one manufacturer and working pressure cast or stamped thereon.
14. The exterior valves shall conform to all applicable requirements of American Water Works Association C500-61 Standard for Gate Valves for Fire Water Work Service.
15. The entire plumbing systems shall be supplied with valves so located, arranged and operated as to give a complete regulating control to all fixtures and apparatus
16. Install check and globe valves on downstream side of the shutoff valve on hot water circulating riser and branch lines.
17. Valves, where exposed and used in connection with finished piping, shall be same finish as the pipe.
18. Provide shut-off valves and check valves on each pump discharge line.
19. All valves used on branch piping to bathroom and kitchens shall be all bronze type globe valves with discs suitable for service to which they are connected.
20. Install valves where required for proper operation of piping and equipment including valves in branch lines necessary to isolate sections of piping. Locate valves so as to be accessible.
21. Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
22. Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves where corrosion is indicated or can be expected to occur.
23. Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
24. Except as otherwise indicated, install ball, globe, and butterfly valves to comply with ANSI B31.1. Where throttling is indicated or recognized as principal reason for valve, install globe valves.
25. Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
26. Select and install valves with renewable seats, except where otherwise indicated.

B. All valves of a given type shall be of one manufacturer.

C. Provide extended stems on insulated system to prevent interference of operator with insulation.

D. Provide chain wheel operators for valves more than 7’ – 0” AFF in mechanical rooms and wherever shown on drawings.

E. If permitted, Grooved end valves shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved end valves shall be the products of a single manufacturer. Grooved end shall be clean and free from indentations and projections. A factory-trained field representative shall provide on-site training for contractor's field personnel in the installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.2 VALVE APPLICATION

Domestic Hot and Cold Water ½" – 2"	Ball Valve
Domestic Hot and Cold Water 2½ " – 10"	Butterfly Valve
Domestic Hot and Cold Water - 6" and larger	Butterfly Valve

3.3 CHECK VALVE INSTALLATION

A. Swing and Check Valves:

1. Install only in horizontal lines unless absolutely impractical. If installed vertically, flow shall be upwards.
2. Do not install in pump discharge piping.

B. Silent Check Valves:

1. Install in all pump discharge lines.
2. Silent check valves may be installed in vertical pipes with flow down upon Engineer's review for each instance.

C. Installation of Check Valves:

1. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position.
2. Horizontal Lift Check Valve: Install in horizontal piping line with stem vertically upward.
3. Vertical Lift Check Valve: Install in vertical piping line with upward flow with stem vertically upward.
4. Air Compressor Lift Check Valve: Install in air compressor discharge line.
5. Spring Loaded Horizontal Lift Check Valve: Install in horizontal piping line with stem vertically upward.

3.4 BACKFLOW PREVENTOR

A. Provide backflow preventors as follows:

1. Reduced pressure at make-up for hydronic systems.
2. Vacuum breaker at all hose bibs.
3. Reduced pressure on domestic water entry.
4. Reduced pressure on irrigation systems.
5. Stainless steel reduced pressure on water lines to carbonated beverage dispensers, ice makers and other food service equipment.
6. Vacuum breaker at all mop sinks.
7. Double detector check at fire protection water service.

B. Provide reduced pressure type master backflow preventer on main domestic water supply and to each fixture and equipment requiring same as indicated on the Drawings and governed by the applicable codes. This shall include, but not be limited to, mechanical equipment, kitchen equipment and equipment specified in other divisions.

C. Provide drain opening and pipe to nearest floor drain or service sink.

3.5 CIRCUIT SETTERS

A. All circuit setters shall be installed per manufacturer's recommendations. Provide manufacturers recommendation for required straight pipe for inlet and outlet connections to provide accurate ratings. Setting shall be as required for proper balanced flow to equipment.

B. Provide circuit setters on all hot water return lines and any other lines requiring controlled flow.

END OF SECTION

SECTION 22 05 29

PLUMBING PIPE SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 STANDARDS

A. Comply with MSS Standard Practice SP-58, SP-69 and SP-89, published by Manufacturer's Standardization Society of the Valve and Fitting Industry for type and size.

1.2 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Hangers other than clevis type.
2. Anchors.

B. Submit structural calculations for trapeze type supports.

PART 2 – PRODUCTS

2.1 PIPE HANGERS

A. General:

1. Use adjustable pipe hangers on suspended pipe. Trapeze hangers may be used at the Contractor's option. Contractor shall be responsible for sizing supports.
2. Chain, wire or perforated strap hangers will not be permitted.
3. Isolate hangers in contact with dissimilar materials with dielectric hanger liners. Tape is not acceptable.
4. Provide supports between piping and building structure where necessary to prevent swaying.

B. Hanger Rods:

1. Exposed in public areas: Zinc electroplated steel.
2. Concealed or in service areas: Black threaded steel.
3. Outside, exposed to weather: Hot dipped galvanized.

C. Spot Concrete Inserts: Steel case and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

1. Size inserts to match size of threaded hanger rods.
2. Inserts to be UL and FM listed.
3. Minimum 1000 lb. Capacity with ½" rod.

D. Channel Type Inserts:

1. Standard channel support with anchor tabs on 4" centers, and nail holes for attaching to forms.
2. Styrofoam inserts to prevent wet concrete seepage.
3. Minimum 2000 pounds/foot capacity.

E. Expansion Anchors:

1. For use only in renovations or where modifications to piping layouts require installation away from pre-installed insert locations.
2. Inserts shall be of the drill, insert, expand type. Power driven fasteners are not acceptable for piping.
3. Contractor shall select the appropriate type based on the following:

Rod Size	Maximum Working Load
3/8	600 pounds
½	1100 pounds
5/8	1800 pounds
¾	2700 pounds

F. Steel Structure Attachments:

1. Contractor may select welded or mechanically attached. All mechanically attached supports shall have jam nuts or other means to prevent loosening. Maximum loading requirements are as follows:

Rod Size	Maximum Working Load
3/8	600 pounds
½	1100 pounds
5/8	1800 pounds
¾	2700 pounds

G. Single Hangers:

1. Piping 2" and smaller: MSS type 1, Clevis hanger or type 7 adjustable swivel ring hanger. Minimum 180 pounds design load.
2. Piping 2" and smaller (steel): Clevis hanger, Anvil Fig. No. 260, F & M Fig. No. 239, Paterson Fig. No. 100.
3. Piping 2" and smaller (copper): Adjustable wrought iron, Anvil Fig. No. CT-65, F & M Fig. No. 364, Paterson Fig. No. 100 CT
4. Piping 2½" and larger: MSS type 1 Clevis hanger.
5. Piping 2½" to 4" (steel): Adjustable swivel pipe roll, Anvil Fig. No. 181, F & M Fig. No. 2729, Paterson Fig. No., 16.
6. Piping 2½" to 4" (copper): Adjustable wrought ring, Anvil Fig. No. CT-69.
7. Piping 5" and above: Two rod roller hanger, Anvil Fig. No. 171, F & M Fig. No. 170, Paterson Fig. No., 142.
8. Bare copper pipe: Above hangers, plastic or Neoprene coating, sized for copper pipe O.D. and copper coated for identification.
9. Insulated pipe: Hangers to be sized for O.D. of insulation. Hangers shall not penetrate any insulation.
10. Cast iron pipe above hangers sized for O.D. of cast iron pipe.
11. Hanger wire, cable or perforated metal strapping are not acceptable.

H. Trapeze hangers and wall supports:

1. Channel strut or structural steel shapes. Contractor shall follow channel strut manufacturers guidelines for loading or provide structural steel supports designed by a professional Engineer, licensed in the state where the project is located.
2. All piping shall be attached to the support by means of a channel strut clamp, U-bolt, or pipe rollers which will maintain lateral position of the pipe but allow longitudinal movement. Provide dielectric isolation between all dissimilar metals.
3. All insulation shall be continuous at supports. Do not notch or penetrate insulation.
4. Kindorf or similar materials used for support of small piping shall not be used for piping 3" or larger.
5. ½" through 3": Unistrut type channel and steel clamp.
   a. Use Hydrosorb cushions on copper pipe.

6. 4" and Over: Welded steel bracket and wrought steel clamp.

I. Vertical Supports: Provide steel riser clamp at each floor penetration or every 14 foot supported from wall bracket. Do not anchor riser clamps. In exposed locations, coordinate clamp locations with Architect.

J. Hangers:

1. General: Adjustable wrought steel clevis with locking nut attachment.
2. Multiple or Trapeze: Steel channels with welded spacers and hanger rods.
3. Hanger Sizes and Spacing:
   a. For drain piping, conform to the code requirements for spacing, and the following table for hanger rod sizes.
   b. For plumbing piping, conform to the following table:

PIPE TYPE	PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING	MINIMUM HANGER ROD SIZE
Steel Pipe	½"	6'-0"	At every story height	3/8"
	¾" thru 1¼"	8'-0"		3/8"
	1½" and 2"	10'-0"		3/8"
	2½" thru 3½"	12'-0"		1/2"
	4" and 5"	12'-0"		5/8"
	6"	12'-0"		3/4"
Copper or copper-alloy tubing	1¼" and smaller	6'-0"	At each story height no greater than 10'	3/8"
Copper or copper-alloy tubing	1½ " and larger	10'-0"	At each story height no greater than 10'	3/8"
Copper Pipe	½" thru 1"	8'-0"	At every story height no greater than 10'	3/8"
	1¼" thru 2"	10'-0"		3/8"
	2½" thru 3"	10'-0"		1/2"
	4"	10'-0"		5/8"
	6"	10'-0"		¾"
Cast Iron Soil	2"	5' And Each Joint	At base and at each story height no greater than 15'	3/8"
	3" to 5"	5' And Each Joint		½"
	6"	5' And Each Joint		5/8"
	8" to 12"	5' And Each Joint		¾"

K. Insulated Pipe Supports:

1. Size pipe supports for outside diameter of pipe insulation.
2. It is not acceptable to cut or notch insulation at support locations.

L. Pipes over five inches and over 120°: Provide cast iron roller supports.

M. Beam clamps - Hangers supported from floor steel shall be approved I beam clamps. I beam clamps for hangers supporting piping 2 inches and smaller shall be C & P Fig. No. 148 adjustable beam clamps. For piping 2-1/2 inches and larger, I beam clamps shall be wrought steel. C & P Fig. No. 268 or equal.

N. Hangers for copper piping shall be copper plated.

2.2 INSULATION INSERTS

A. Pipe shall be protected at the point of support by an insert of high density, 100 psi, waterproofed calcium silicate, or Hi-Low Temp insert, encased in a sheet metal shield. Insert to be same thickness as adjoining pipe insulation. Insulation insert to extend one inch beyond sheet metal shield on all "cold" lines. If pipe hanger spacing exceeds ten feet and for all pipe roller applications, utilize double layer shield on bearing surface.

B. Provide 180º insulation inserts when utilizing clevis hangers. Provide 360º insulation inserts at all trapeze and wall supports.

2.3 PIPE ANCHORS

A. Manufacturers:

1. Design Basis: Flexonics
2. Other Acceptable Manufacturers:
   a. Adsco
   b. Keflex
   c. Hilti

B. Model AC with threaded ends and welded angle brackets for steel pipe.

C. Model AC copper tube with solder ends and steel angle brackets brazed to tubing for copper tube.

D. Anchors may be field fabricated similar to manufactured products specified.

2.4 PIPE GUIDES

A. Manufacturers:

1. Basis of Design: B-line.
2. Other Acceptable Manufacturers:
   a. Fee & Mason
   b. Anvil
   c. M-Co
   d. PHD

B. Any of the Following:

1. Spider Type: B3281-7.
2. Roller Type: 2 sets of rollers on opposite sides of pipe.
3. Slide Type: B3893 with hold down lugs.
   a. Not for use with cold piping.
4. Light duty, 1½" and smaller copper: U bolt or channel strut clamp (B2417) allowing clearance from O.D. of pipe or insulation.

2.5 ROOF MOUNTED PIPING

A. Manufacturers:

1. Miro Industries, Inc.
2. Portable Pipe Hangers, Inc.
3. Approved Equivalent.

B. Description: Where roofs are not being replaced, piping on roof shall be supported by an engineered prefabricated portable pipe system specifically designed to be installed on the roof without roof penetrations, flashing or damage to the roofing material. The system shall consist of recycled rubber or plastic bases, hot dipped galvanized or stainless steel frame with threaded rods and suitable pipe hangers and supports. The system shall be custom designed to fit the piping and conduits to be installed and the actual conditions of service.

C. Piping on areas of roof being replaced shall be installed on pipe curbs bearing on roof structure and flashed into roofing material.

D. Provide seismic restraints as required for seismic zone.

PART 3 – EXECUTION

3.1 INSTALLATION OF PIPE SUPPORTS

A. Adequately support piping from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging and pocketing.

1. Provide supports between piping and building structure where necessary to prevent swaying.
2. Do not support pipe from other pipe or equipment.
3. Provide thrust restraints at all changes in direction on 8" and larger cast iron piping with no hub or hub and spigot fittings.

B. Install hangers to provide minimum ½" clear space between finished covering and adjacent work.

1. Place a hanger within one foot of each horizontal elbow.
2. Space hangers generally as called for in Table in Part 2, Products.

C. Use hangers, which are vertically adjustable 1-½" minimum after piping is erected.

D. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

1. Set inserts in position in advance of concrete work.
2. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
3. Do not penetrate concrete "TT" legs for piping inserts. Do not penetrate the stressed (i.e. lower) chords of any structural member.

E. Provisions for Movement: Install hangers and supports:

1. To allow controlled movement of piping systems.
2. To permit proper movement between pipe anchors.
3. To facilitate the action of expansion joints, expansion loops, bends and offsets.
4. To isolate force due to weight or expansion from equipment connections.

F. In general, attach hangers to upper chord of roof trusses and floor joists, using long rods to facilitate pipe movement.

G. Anchors:

1. Arrange piping such that pipe expansion and contraction is accommodated by controlled movement of the pipe within the pipe supports. Provide sufficient offsets in branch piping to accommodate movement of main piping due to expansion and contraction. Where this is not possible due to magnitude of expansion or building geometry, securely anchor piping where required for a proper installation and to force the pipe expansion in the proper direction.

2. Anchors shall be suitable for the location of installation and shall be designed to withstand not less than five times the anchor load.
3. Anchor vertical pipes by means of clamps welded around pipes and secured to wall or floor construction. Anchor at bottom of riser only but provide guides for vertical thermal movement.
4. All anchors shall be separate and independent of all hangers, guides, and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work approved by the Architect. Anchors shall be welded to the pipe and fastened to the structure with bolts.
5. Anchors shall be fabricated and assembled in such a form as to secure the piping in a fixed position. They shall permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points: and shall be so arranged as to be structurally suitable for particular location, and line loading. Submit details for approval.

H. Assume the responsibility for the proper transfer of the loads to the piping systems to the structure. No additional cost to the owner should be expected for any corrective work during construction.

I. Provide necessary structural members, hangers, and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc., are supported from metal decking and/or concrete construction, care shall be taken not to weaken decking and/or concrete or penetrate waterproofing. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted, both in the vertical and horizontal direction, when the supported piping is hot.

J. Provide supplemental bolted steel in all locations where drilling of slab will create unacceptable noise in adjacent spaces.

K. Where piping is run near the floor and not hung from the ceiling construction but is supported from the floor, such supports shall be of pipe standards with base flange and adjustable top yoke similar to C & P Fig. 247 or equal.

L. All vertical piping shall be anchored by means of heavy steel clamps securely bolted or welded to the piping, and with end extension bearing on the building.

M. Vertical runs of pipe not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs.

N. Vertical runs of pipe over 15 feet long but not over 60 feet long and not over 6 inches in size, or not over 30 feet long and not over 12 inches in size, shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and shall reset securely on the building structure without blocking. Clamps shall be welded to the pipes or placed below couplings. Clamps shall be type 8, Federal Specification WW-H-171C, unless other types are approved.

O. Piping in trenches shall hang from angle iron cross supports provided by the Contractor with two coatings of red lead primer and final coat of black asphaltum paint.

P. Hanger rods shall be attached to preset concrete inserts with steel reinforcing rod through the insert and both ends hooked over the reinforcing mesh. For pipes 4 inches and larger, rods shall extend through concrete slab above where they shall be attached to steel bearing plates 6" x 6" x 1/4".

Q. Piping shall not be hung from other piping, ducts, conduits or from equipment of other trades and no vertical expansion shields will be permitted. Hanger rods shall not pierce ducts.

R. All piping running on walls shall be supported by means of hanger suspended from heavy angle iron wall brackets. No wall hooks will be permitted.

END OF SECTION

SECTION 22 05 53

PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Plastic Pipe Markers and method of application.
2. Engraved Plastic Laminate Sign.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products.

B. Where more than a single type is specified for an application, selection is Installer's option, but provide a single selection for each application.

2.2 PLASTIC PIPE MARKERS (TYPE A)

A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.

B. For Pipes Less Than Six Inches (including insulation if any): Provide full-band pipe markers, extending 360º around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than ¾" wide; full circle at both ends of pipe marker, tape lapped 1-½".

C. For Pipes Six Inches and Larger (including insulation if any): Provide either full-band or strip-type markers, but not narrower than 3 x letter height, taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-½" wide; full circle at both ends of pipe marker, tape lapped 3".

D. Lettering: Manufacturer's pre-printed wording which conforms to contract document system descriptions.

E. Where work is an extension or alteration of an existing system, new markers shall match existing terminology for systems which are modified or added by this work.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering or as a separate unit of plastic (to accommodate both directions).

2.3 STENCILING (TYPE B)

A. Using a color contrasting to the surface to identify, spray or brush paint through neatly cut stencils.

B. Lettering shall conform to wording on contract documents. Size shall be in accordance with ANSI A13.1.

2.4 BACKGROUND COLOR AND STENCILING (TYPE C)

A. In addition to the requirements above, paint a background color band in accordance with ANSI A13.1.

2.5 VALVES TAGS

A. Brass Valve Tags: Provide manufacturer's standard 19 ga brass tag; approximately 1-½" round wit ½" high black filled numbers and 3/16" top hole.

1. Numbers shall be sequential in accordance with schedule below.
2. Provide separate numbering for each legend sequence. Provide separate sequences for the following:
   a. Plumbing (PLBG)
   b. Domestic Cold Water (DCW)
   c. Domestic Hot Water (DHW)
   d. Domestic Hot Water Return (DHWC)
   e. All other systems (No legend)

B. Valve Tag Fasteners: Manufacturer's standard chain (wire link or beaded type), or S-hooks.

2.6 VALVE SCHEDULE

A. Provide schedule for each piping system, as defined on the drawings, and below, typewritten and reproduced on 8-½" x 11" bond paper.

B. Tabulate valve number, piping system, system legend (as shown on tag), location of valve (room or space), and variations for identification (if any).

C. Provide piping schematic for each system as defined below in Part 3.

D. In addition to mounted copies, furnish extra copies for maintenance manuals as specified.

E. Valve Schedule Frames: For each page of the valve schedule, provide a glazed frame, with screws for removable mounting on masonry walls.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, 1/16" thick, black with white core (letter color).

B. Fastening:
1. Screws
2. Rivets
3. Permanent Adhesive

C. Lettering and Graphics:

1. Coordinate names, abbreviations and other designations used in the mechanical identification work, with the corresponding designations shown, specified or scheduled in the construction documents.

PART 3 - EXECUTION

3.1 GENERAL

A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting.

B. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers on piping of the following systems and include arrows to show normal direction of flow.

1. Domestic water piping (hot, cold, tempered; 120º hot, 140º hot, hot water re-circulating, etc.).
2. Plumbing vent and sanitary (above grade) piping.
3. Storm piping.

B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces above accessible ceilings, in accessible maintenance spaces, including chases, and above ceiling:

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where there could be a question of flow pattern.
3. Near locations where pipes pass through walls, floors, or ceilings, or enter non-accessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 25’ along each piping run.
6. Within 6’ of access doors above otherwise non-accessible ceilings and chases.

C. Type:

1. Normally exposed to view - Type A or C.
2. Normally concealed from view - Type B.

3.3 VALVE IDENTIFICATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixtures faucets, hose bibs, and shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

1. Shut off valves located at least 10’ from fixture(s) shall be provided with valve tag unless otherwise directed by Engineer.

B. Mount framed valve schedules with piping schematics where directed by Architect.

C. Identify each valve tagged on as-built drawings.

3.4 NON-POTABLE WATER IDENTIFICATION

A. Provide an engraved plastic laminate sign.

1. Legend: “Non-Potable Water”.
2. Location: At each outlet of piping between backflow preventer and equipment served. (e.g. Boiler Room hose bibb).

END OF SECTION

SECTION 22 05 93

TEST-ADJUST-BALANCE

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. A work of this section shall be completed by a sub-contractor of the Plumbing contractor.

B. The Balancing Contractor shall not be a sub-contractor of any other Division 21, 22 or 23 Contractor.

1.2 QUALITY ASSURANCE

A. Qualification:

1. The firm shall be an independent testing and balancing firm specializing in testing and balancing of environmental systems.
2. The firm shall have an experience record of not less than five (5) years experience in the testing and balancing industry.

B. Registration: Work shall be done under the supervision of a professional engineer registered in the jurisdiction of the work. Engineer shall be available for all meetings and interpretation of all materials in the report.

C. Pre-qualification of Testing and Balancing Contractor.

1. The firm must have experience and qualifications satisfactory to the consulting mechanical engineer and must be accepted by him prior to bidding.
2. Firms desiring approval to provide work under this section shall submit a booklet indicating procedures and data forms that they would use in the performance of the work.
3. Only firms which have been approved by the engineer may provide work under this section.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

A. Sequence work to commence after completion of system and start-up procedures and schedule completion of work before Substantial Completion of Project.

B. Examine the installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable.

C. Notify the Contractor in writing of conditions detrimental to the proper completion of the test-adjust-balance work.

1. Do not proceed with the work until unsatisfactory conditions have been corrected.
2. Provide Engineer/Architect with a copy of the notification.

D. Adjust flows to within 10% of values shown. If design flows cannot be obtained within specified limits the Balancing Contractor will perform the following (at the minimum):

1. Measure and record major pressure drops in the system.
2. Consult with the Engineer and Installer as required.
3. Upon receiving written directions to proceed and after any corrections are performed, re-balance affected portion of system.

E. Optimization: Work closely with the plumbing contractor to optimize setpoints.

1. Establish the minimum water differential pressure for variable or bypass flow system.
2. Establish the position of valve and sequencing relays.
3. Confirm suitable operation of all backflow prevention devices.
4. Confirm proper operation of hot water return system.
5. Confirm proper flow through all heat exchangers.

F. Patch holes in insulation and housings which have been cut or drilled for test purposes, in a manner recommended by the original Installer.

G. Make all final readings for each system at the same time, and after all adjustments have been made.

H. Mark equipment settings, including control positions, balancing cocks, circuit setters, valve indicators, to show final settings at completion of test-adjust-balance work.

1. Mark with paint or other suitable permanent identification material.

I. Check all new thermal overloads.

1. Identify improperly protected equipment in report.

J. All piping and equipment shall be tested; labor including standby electrician, materials, instruments and power required for testing shall be furnished unless otherwise indicated under the particular section of the Specification.

K. Tests shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

L. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their ratings.

M. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architects.

N. Any damage resulting from tests to any and all trades shall be repaired and damaged materials replaced, all to the satisfaction of the Architect.

O. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed below.

P. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated and depends upon the operation of other equipment, systems and controls for proper operation, functioning and performance, and latter shall be operated simultaneously with the equipment or system being tested.

Q. All pumps and piping systems shall be completely balanced by the adjustment of the plug cocks, globe valves or other control devices, to obtain the flow quantities indicated on the design drawings.

3.2 DOMESTIC WATER SYSTEMS

A. Before any adjustments are made:

1. Check temperature control valve operation.
2. Check pump rotation.
3. Adjust pressure reducing valve.
4. Remove any roughing strainer screens in systems.

B. Procedure:

1. Measure and report all domestic water recirculation systems by all of the below means which are applicable.
   a. System, pump, branch, or terminal flow measuring stations.
   b. Terminal or heat exchanger pressure drop, compare to submittal data.
   c. Plot operating point on system graph.

3.3 DETAILED REQUIREMENTS

A. Measure, adjust and report the following:

1. Pumps (including ejectors and sump pumps):
   a. Water flow
   b. Inlet and outlet pressure
   c. Motor amps and KW
2. Heat Exchangers:
   a. Cooler fluid inlet and outlet temperatures
   b. Cooler fluid flow
   c. Warmer fluid inlet and outlet temperatures
   d. Warmer fluid flow

3.4 REPORT

A. Provide a general information sheet listing:

1. Instruments used:
   a. Most recent calibration date.
2. Method of balancing.
3. Altitude correction.
4. Manufacturer’s performance data for all air devices used.

B. Provide data sheets for all equipment, including motors and drives, listing:

1. Make
2. Size
3. Serial number
4. Capacity Rating
5. Amperage
6. Voltage input
7. Thermal heater size for each motor
8. Operating speed of driver and driven devices
9. Any additional pertinent performance data

C. Include design and final values for all items listed in Detailed Requirements, and totals for each system.

D. Provide data sheets showing:

1. Instrument used
2. Velocity reading
3. Manufacturer's free area factors

E. Provide recap sheet with explanation for each device not meeting specified performance.

F. Provide a set of prints with equipment, inlets and outlets marked to correspond to data sheets.

3.5 COMMISSIONING

A. Provide all necessary personnel, tools and equipment to comply with the commissioning scope.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Insulation.
2. Jackets, coatings and protective finishes.
3. Sealers, mastics and adhesives.
4. Fitting covers.

1.2 FLAME AND SMOKE RATINGS

A. Provide insulation tested on a composite basis (insulation, jacket, covering, sealer, mastic and adhesive) complying with the following for:

1. Flame Spread: 25 or Less
2. Smoke Developed: 50 or Less
3. Method: ASTM E84 (NFPA 255), UL 723

B. Accessories such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above. All products shall bear UL labels indicating the above are not exceeded.

1.3 PRODUCT DELIVERY

A. Deliver insulation products in factory containers bearing manufacturer's label showing fire and smoke hazard rating, density and thickness.

B. Protect insulation against, dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

C. Store insulation in original wrappings and protect from weather and construction traffic.

1.4 DEFINITIONS

A. Exposed Location: Located in mechanical rooms or other areas exposed to view.

B. Concealed Location: Located in pipe chases, furred spaces, attics, crawl-spaces, above suspended ceilings, or other locations not exposed to view.

1.5 STANDARDS

A. Comply with the latest edition of National Commercial and Industrial Insulation Standards.

B. Provide certifications or other data as necessary to show compliance with these Specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Manufacturers:

1. Design Basis: Johns-Manville
2. Other Acceptable Manufacturers:
   a. Armacell
   b. Foster
   c. Owens-Corning
   d. Knauf
   e. KFlex USA
   f. Imcoa
   g. Pittsburgh Corning

B. Materials:

1. Fiberglass Pipe Insulation with Vapor Barrier: Johns-Manville Micro-Lok heavy density pipe insulation with AP-T jacket or Owens-Corning Fiberglass Corp. ASJ/SSL-11.
2. Fiberglass Pipe Fitting Insulation: Johns-Manville “Zeston” fitting covers with factory-cut fiberglass insulation insert. Insulation blanket with foil tape and tie wire will not be accepted.
3. Flexible Unicellular Pipe Insulation: Armstrong Armaflex, II or Therma-cel By Nomaco.
4. Cellular glass with vapor barrier coating: Pittsburgh Corning.
5. Rigid Closed Cell Insulation: ITW Insulation Trymer 2000 XP(not for use indoors).
6. Vapor Barrier Mastic: Foster 30-65 or Childers CP-34; permeance shall be 0.03 perms or less per ASTM E96. Mastic must meet California Dept. of Public Health (CDPH) Standard Method Ver. 1.1,2010 Small Scale Environmental Chamber Test for VOCs. for CA Specification 01350 and LEED IEQ 4.2.
7. Weather Barrier Mastic: Foster 46-50 or Childers CP-10/11. For use on hot service pipe.
8. Lagging Adhesive: Foster 30-36 or Childers CP-50AMV1.
9. Fiberglass Adhesive: Foster 85-60 or Childers CP-127.

C. Thickness: (Thickness listed below are minimum required. Provide thickness required by Local Building or Energy Codes).

1. Service (Domestic) Water Piping:
   a. Hot:
      1) 1½ ” and Smaller: 1½ ”
      2) 2” and Larger: 2”:
      3) Non Recirulated Runouts up to 2” and 8 feet long: ½"
   b. Cold: 1½”
2. Storm Water:
   a. All Sizes: 1”
3. Solar Collector Supply and Return Piping:
   a. Inside House: 1½”
   b. Below Grade: 1½”
   c. All Other: 2”
4. All Heat Traced Piping:
   a. Size 2” and smaller: 1½”
   b. Size 2½” and larger: 2”

D. Application: Unless otherwise indicated, use the following:

1. Inside, concealed: Fiberglass with a maximum K factor of 0.22 BTU/inch per sq. ft. per degree F. per hour at 75˚F. mean temperature with factory-applied all service vapor proof jacket. Density shall be not less than 3 lbs. per cubic foot. For hot pipe insulation, insulation shall be suitable for 250˚F.
2. Inside, exposed: Fiberglass pipe insulation with vapor barrier and PVC jacket (jacket not required in mechanical rooms).
    a. A vapor barrier mastic compatible with the PVC shall be applied around the edges of the adjoining pipe insulation and on the fitting cover throat overlap seam. The PVC fitting cover is then applied and shall be secured with pressure sensitive pearl gray Z-Tape along the circumferential edges. The tape shall extend over the adjacent pipe insulation and have an overlap on itself at least 2" on the downward side.
    b. 2 or more layers of the Hi-Lo Temp insulation inserts shall be applied with the first layer being secured with a few wrappings of fiberglass yarn.
    c. Qualifications for Using Insulation: Use one Hi-Lo Temp insert for each additional 1" of pipe insulation.
    d. Fitting Cover: the temperature of the PVC fitting cover must be kept below 150˚F by the use of proper thickness of insulation and by keeping the PVC cover away from contact with, or exposure to, sources of direct or radiant heat.
3. Outside, protected: Fiberglass pipe insulation with vapor barrier and aluminum jacket.
4. Outside, exposed to weather: Rigid closed cell pipe insulation with aluminum jacket.
5. Below grade or slab:
    a. Pipe size 1½” and less: Single piece of flexible closed cell insulation slipped over soft annealed copper tube without slitting insulation.
    b. Pipe size 2” and larger: Pre-Insulated System (Perma-Pipe, or equal) with rigid closed cell insulation and shrink fit jacket.
6. PVC: 1½” thick fiberglass (duct) insulation, or 1” heavy density pipe insulation installation to meet ASTM E84 (NFPA 255) flame spread and smoke developed ratings.
7. All fittings, valves and flanges for pipe sizes 4" and larger shall be insulated with fabricated mitered segments of pipe insulation of same thickness as the adjoining pipe insulation, secured with no. 20 gauge galvanized annealed steel wire and covered with Zeston 2000 molded PVC fitting covers as manufactured by Manville or equal.
8. Direct contact between pipe and hangers will not be accepted. Hangers shall pass outside of a metal saddle which shall cover a section of high density insulation of sufficient length to support pipe without crushing insulation. Hangers shall not pierce insulation and all vapor barriers shall be unbroken and continuous. High density insulation shall be one of the following:
    a. Foam glass.
    b. Fiberglass, high density, minimum of 7 lb. material or heavier.
    c. High density calcium silicate insulation.
9. Provide vapor barrier dams at locations and intervals recommended by the insulation manufacturer, maximum 20’ spacing.

2.2 EQUIPMENT INSULATION

A. Manufacturer:

1. Design Basis: Johns Mansville
2. Other Acceptable Manufacturers:
    a. Armstrong
    b. Certainteed
    c. Owens-Corning
    d. Knauf
    e. Pittsburgh Corning

B. Materials:

1. Insulation: 3" thick flexible board type insulation. 3 PCF glass fiber insulation with all purpose jacketing. Maximum thermal conductivity .27 BTU-IN/(hr-FT^2-ºF) at 150ºF. Glass fibers oriented such that insulation will conform to rounded shapes while maintaining high compressive strength.
2. Jacketing Material: PVC or aluminum jacketing material, except as otherwise indicated. Seal all joints.
3. Fiberglass: Johns-Manville Micro-Lok 850 insulation with APT jacket.
4. Flexible Unicellular Insulation: Armstrong Armacell sheet form.

C. Application:

1. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, metal covers, adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify acceptability of all materials which are to be used in air plenums (above ceiling, etc.). Materials must meet all requirements of Local Building Code and Authority having jurisdiction.

B. Insulation Packing:

1. Piping:
   a. Wherever piping penetrates walls, partitions, floor slabs, etc., the space between the piping and the sleeve shall be packed with mineral wool and sealed with approved type non-hardening caulking compound for sleeves through exterior walls.
2. Material:
   a. Packing material shall be rockwool insulation as manufactured by United Stated Gypsum Co. or equal and shall comply with Fed. Spec. HH-1-558, Form A, Class 4, K=0.24, melting point 2000˚F.

C. All Lines That Are Electrically Traced

1. The basic insulation shall be dual temperature, Manville Micro-Lok piping insulation, 1½" thick. The insulation shall be sized to accommodate the electric heat tracing applied against the pipe surface.
2. Finish for insulation shall be .02 aluminum.

D. Contractor shall examine location where this insulation is to be installed and determine space conditions and notify the Architect in writing of conditions detrimental to proper and timely completion of the Work.

E. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION

A. Install insulation in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that insulation complies with requirements and serves intended purposes.

B. Coordinate with other work as necessary to interface installation of insulation with other components of systems.

C. All insulating materials shall be applied only by experienced workmen, in accordance with the best covering practice. All piping equipment shall be blown out, cleaned, tested and painted prior to the application of any covering. Adhesives, sealers and mastics shall not be applied, when the ambient temperature is below 40˚F, or surfaces are wet.

3.3 PIPE INSULATION

A. Insulate the following:

1. Domestic hot water piping.
2. Domestic cold water piping above ground and under slab.
3. Roof drain bodies and all horizontal storm water piping.
4. Solar energy system piping.
5. All existing piping which is currently insulated and which is modified as a result of this work.
6. Crotons
7. Heat traced piping.
8. All storm piping in areas provided with humidification control.

B. Installation:

1. Install insulation on pipe system subsequent to testing and acceptance of tests.
2. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.
3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
4. Extend piping insulation without interruption through pipe clamps, hangers, walls, floors and similar piping penetrations, except where otherwise indicated.
5. Install protective metal shields and saddles where needed to prevent compression of insulation.
6. Except as noted, cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run.
   a. Install factory-molded, pre-cut or job-fabricated units (at Installer's option), except where a specific form or type is indicated.
   b. Do not cover:
      1) Valve operators. Provide extended valve stems as required to maintain continuous insulation and vapor barrier.
      2) Nameplates or identification tags.
   c. Provide removable access for:
      1) Strainers.
      2) Other components requiring access for service.
7. Mark location of unions and flanges covered by insulation with permanent paint or ink, or approved label.
8. Maintain integrity of vapor-barrier jackets on insulation of cold pipes and storm drainage piping, and protect to prevent puncture or other damage. Insulation on cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold services shall be adequately insulated and vapor sealed to prevent condensation.
9. Inserts shall be installed at hangers for insulated piping. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of equal thickness to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

2-1/2" pipe size and smaller	6" long – 18 GA
3" to 6" pipe size	9" long – 16 GA
8" to 10" pipe size	12" long – 12 GA

10. Provide 18 gauge galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit insulation. Extend shields up to centerline of pipe. Make shields same length as that specified above for inserts.
11. Where insulation is specified for piping, insulate similarly all connections, vents, drains, and any piping connected to system.
12. Fill surface imperfections such as chipped edges, small joints or cracks and voids or holes with insulation material and smooth all such areas with a skim coat of insulating cement.

13. Seal ends of sections with Foster 30-65 or Childers CP-34 vapor barrier mastic and reinforcing mesh to crate moisture dams at:
    a. 20 ft. intervals.
    b. Valves and fittings.
    c. All hangers and supports.
14. On underground pipe insulation, install unicellular insulation on pipe without slitting insulation. Seal all transverse joints with adhesive.
15. Replace existing insulation removed or damaged because of work of this project.
16. Insulate new pipes and replace insulation on existing pipes to remain where insulation was removed or damaged by demolition or revisions.
17. Insulate between fingers of spiders in alignment guides.
18. Insulate between pipe and pipe slide.
19. All domestic water piping installed within piping chases behind fixtures (“crotons”) must be fully insulated to the back of the wall behind the fixture.
20. All equipment shall be insulated, including circulator pumps, circuit setters, strainers, etc. Provide valve and trim extensions as required to maintain the minimum insulation thickness.
21. Perform all work in a neat and workmanlike manner. Poor work (as determined by Architect or Engineer) will be cause for rejection.
22. Specialties shall be insulated to match those of the systems to which they are connected.
23. No insulation shall be installed until the piping systems have been hydrostatically tested as specified elsewhere to the satisfaction of the Engineer.

3.4 OUTDOOR PIPE INSULATION

A. Install insulation with butt joints of half pipe sections staggered. Insulation shall be held in place with strapping tape. Install aluminum jacket with all joints lapped to shed water. Apply a bead Foster 95-44 or Childers CP-76 metal jacketing sealant at all transverse and longitudinal seams. Secure with aluminum bands, minimum of 2 per jacket section.

3.5 EQUIPMENT INSULATION

A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces, after inspection and release for insulation application.

    1. Re-do poorly fitted joints.
    2. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

C. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

D. Do not insulate handholes, cleanouts, ASME stamp and manufacturer’s nameplate.
Provide neatly beveled edge at interruptions of insulation.

E. Do not apply insulation to equipment above 125° F.

F. Heat Exchanger + Converters

    1. Cover top and both sides of exchanger with 24 gauge galvanized steel panels with 1” flexible unicellular insulation cemented to the inside of the panels.
    2. Panels shall be easily removable and easy to re-install.
    3. Adhere flexible unicellular insulation to end plates with Armstrong No. 520 adhesive.
    4. Insulate with 2" thick fiberglass, 3# density U.L. Labeled insulation and hexagonal mesh wire screen finished with glass jacket adhered and coated with two coats of Foster 30-36 or Childers CP-50AMV1 lagging

adhesive. Flanges shall be treated as specified under Hot Pipe Insulation.

G. Domestic Water Tanks:
1. Insulate domestic water tanks (hot and cold) with 2 inches of pipe and tank insulation of 1½ inches of rigid fiber glass board (if not originally insulated from the factory).

H. Cold Equipment (At or below ambient equipment):
1. Includes plumbing system equipment such as expansion tanks, vessels, filters, etc.
2. Insulate cold equipment with 2 inches of pipe and tank insulation or 2 inches of rigid fiberglass board.
3. Vapor barrier to be provided on cold equipment insulation.
4. The Contractor shall have the option of using 2" thick fiberglass Bend-A-Board insulation with .016" thick aluminum jacket with lock seams at longitudinal seams and ½" aluminum bands 12" on center at traverse joints. Joints and jacket shall provide complete protection for the insulation.

3.6 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including any damage to continuous vapor barrier or damage due to moisture saturation. The insulation installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 22 08 00

PLUMBING SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: The Work of this Section shall include but not be limited to the following:

1. Systems and equipment Start-Up and Functional Performance Testing.
2. Validation of proper and thorough installation of Division 22 systems and equipment.
3. Generic Start-Up Documentation for mechanical systems and equipment.
4. Development of final Start-Up Documentation for mechanical systems and equipment.
5. System Start-Up and Turn-Over procedures.
6. Systems balancing verification.
7. Coordination and execution of Training Events.

B. Related Sections

1. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.
2. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.3 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 22 Contractors. Requirements common to all Sections are specified in Section 01 91 00 and Section 01 91 10 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.4 SCOPE

A. The following are included in the Scope of Commissioning on this project:

B. Plumbing Systems

1. Domestic hot water

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 01 91 00, Contractor shall provide to the CxA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in PDF electronic format. These may include but are not limited to:

a. Pump Capacity

2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:

a. Pipe Pressure Testing
b. Gas Cross-Contamination
c. Potable Water Disinfection

1.8 SEQUENCING AND SCHEDULING

A. Refer Section 01 91 00.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Commissioning Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off meeting. Contractor shall have input in the protocols and all Parties will commit to scheduling obligations. The CxA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 22.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer's application, installation and start-up information.
4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.

5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-Up, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically in Part I of this Section.
7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 01 09 00. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase

1. Assist CxA in functional performance testing. Assistance will generally include the following:
   a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 01 91 00 and Section 01 91 10; in some cases this will entail only an initial sample);
   b. Provide any specialized instrumentation necessary for Functional Performance Testing;

D. Warranty Phase

1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Provide representative for off season testing as required by CxA.
3. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION

A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA

A. Refer to Section 01 91 00.

1.15 FUNCTIONAL PERFORMANCE TESTING

A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.16 FPT ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.

1.17 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS

A. Refer to Section 01 91 00 the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

B. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.

C. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

D. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

E. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems shall be provided by CxA.

F. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 01 91 00 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP DOCUMENTION COMMON TO ALL SYSTEMS

A. The following Start-Up Documentation (Checklists and Tests) shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer's recommendations.
6. Verify system has undergone Start-Up per the manufacturer's recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all gauges and test ports are provided as required by contract documents and manufacturer's recommendations.
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all rotating and moving parts are properly lubricated.
15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.3 VALVES

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
2. Verify actuators are properly installed with adequate clearance.
3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
5. For electronically operated valves, check the stroke and range.
6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAUGES

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Adjust faces of meters and gauges to proper angle for best visibility.
2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 PLUMBING IDENTIFICATION

A. Start-Up Checks: Perform the following checks:

1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.6 PLUMBING INSULATION

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.

1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.

2. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 PIPING - GENERAL

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: These procedures apply to all installed piping systems, including underground site utilities.

1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
4. Provide notification of pipe cleaning and flushing activities.
5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
6. Ensure adequate drainage is provided at low points and venting is provided at high points.
7. Ensure facilities to effectively drain and fill the system are in place.
8. Ensure air is thoroughly removed from the system as applicable.
9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
10. Provide notification of pressure testing.
11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
13. Submit pressure test reports that document the pressure testing results with certification of the results.
14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
15. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Verify proper alignment, installation, and rotation.
2. Verify properly sized overloads are in place

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Measure insulation resistance, phase balance, and resistance to ground.
2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
3. Record all motor nameplate data.

3.9 BEARINGS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions. This applies to all bearings on fans, pumps, compressors, and other equipment installed under this Division.

1. Check alignment as applicable.

2. Lubricate all bearings per the manufacturer’s instructions. When bearing is used for temporary conditioning, lubricate on manufacturer’s recommended frequency and document it.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer’s recommendations.

2. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak-to-peak acceleration. Compare it to the Vibration Severity Chart. Rectify any condition causing severity indicated as “Rough” or worse.

3.10 PUMPS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to ‘AC Motors’ in this Section.

C. Refer to ‘Bearings’ in this Section.

D. Refer to Division 22 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

E. Start-Up Checks: Perform the following checks during start-up:

1. Check suction lines connections for tightness to avoid drawing air into the pump.
2. Clean and lubricate all bearings.
3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
5. Clean associated strainers.
6. Check that the proper overloads have been installed in the starter and are the correct size.
7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
8. Align pump within manufacturers recommended tolerances.

9. Ensure all associated piping has been cleaned, tested, and deaerated.
10. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

F. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Start the pump per the manufacturer's instructions.
2. Check the general mechanical operation of the pump and motor.
3. Verify that check valve seal is appropriate.
4. Check noise and vibration levels and ensure they are within the manufacturer's recommended tolerances.
5. Check that the NPSH is with that allowable for the operating condition.
6. Refer to Division 22 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.11 CONTROLLERS AND CONTROL PANELS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:

1. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
2. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
3. Check power supplies for proper voltage ranges and loading.
4. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
5. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
6. Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
7. Ensure that all outputs and devices fail to their proper positions/states.
8. Ensure that buffered and/or volatile information is retained through power outage.
9. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
10. Check for adequate grounding of all BAS panels and devices.
11. Run self-diagnostic routines and ensure they are functional
12. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.

3.12 PLUMBING FIXTURES

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
3. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
4. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
5. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

6. Replace washers of leaking and dripping faucets and stops.
7. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

3.13 WATER HEATERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.

1. Check for adequate combustion air.
2. Check for piping connections leaks.
3. Check for clear vent.
4. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

C. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance. Review data in Operating and Maintenance Manuals.

3.14 HYDRONIC PIPING

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:

1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1
2. Flush system with clean water in accordance with applicable Section.
3. Clean strainers.
4. Check expansion tanks to determine that they are not air-bound and that the system is completely full of water.
5. Set automatic fill valves for required system pressure.
6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
7. Set and coordinate automatic fill pressure and relief valve settings.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.15 SITE SANITARY AND STORM SEWERS

A. Test completed sewer lines with light or reflected light. Test shall show clear unobstructed view between manholes. All of the Work will be subject to the final approval of the Architect.

B. The construction of the sewer line shall be inspected by the Architect and Local Authorities.

C. The completed sewer systems, including all mains, laterals, and manholes shall be limited to a maximum leakage limit of 1000 gallons per inch of diameter, per day, per mile.

D. Any completed collection system or partial system failing to meet the maximum allowable infiltration requirements shall be reconstructed or sealed in a manner acceptable to the Architect and the Local Authorities.

E. The gravity sanitary sewer lines shall have all openings tightly closed with screw plugs, or equal device. The piping shall be filled with water and proven tight under a pressure equal to 10'-0" head of water for a minimum of two (2) hours. Water level must remain constant throughout test without addition of water.

3.16 SITE AND UNDERGROUND WATER PIPING

A. The new water main shall be given pressure and leakage tests in Section of approved length all as directed and approved by the Architect. Hydrostatic and leakage tests shall conform to AWWA C600-64 requirements. For these tests, this Contractor shall furnish a water meter and a pressure gauge. This Contractor shall furnish and install suitable temporary testing plugs, valves or caps for the pipeline, all necessary pressure pumps, pipe connections, other similar equipment, and all labor required. All expenses involved in making leakage and pressure tests shall be borne by this Contractor. The meter gauge shall be installed by this Contractor in such a manner that all water entering the Section under test will be measured and the pressure in the Section indicated, and shall be kept in use during both tests. The Sections of pipe to be tested shall be filled with water of approved quantity and all air shall be expelled from the pipe.

B. The new water main shall be subject to a hydrostatic test of 200 psi gauge, after the pipe is laid and the trench partially backfilled (joints shall be left exposed). The test pressure shall be applied to each valved section and maintained for a period of two (2) hours with no more than 2 psi loss of pressure. If this Contractor cannot achieve the specified pressure and maintain it for a period of two (2) hours, the section under test shall be considered as having failed to pass the pressure test.

C. If the section tested shall fail to pass the pressure test or the leakage test, or both, this Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, joint, etc., without extra cost to the Owner.

D. If, in the judgment of the Architect, it is impractical to follow the foregoing procedures exactly for any reason, required modifications in procedures shall be made, but in any event, this Contractor shall be responsible for the ultimate tightness of the lines within the above leakage requirements.

3.17 INTERIOR DOMESTIC WATER SYSTEMS

A. Domestic cold, hot and hot water circulation system: The entire water supply system shall be tested to a hydrostatic pressure of 150 pounds per square inch or 1-1/2 times the system pressure, whichever is greater, at lowest point of the water system in the building, and proved tight at this pressure before fixtures are installed. Water supply piping, if in any way concealed by structural work, shall be tested to the aforesaid pressure and proved tight before pipes are concealed.

B. The test pressure shall be held for a period of not less than two (2) hours. The piping system shall be considered tight if the drop in pressure does not exceed 2 pounds per square inch during the test period. If the pressure drop exceeds 2 pounds, all repairs and alternations in the piping system necessary to meet the test shall be made.

C. Refer to Section 22 10 00 for sanitizing requirements of the domestic water system.

3.18 INTERIOR SANITARY WASTE AND STORM WATER SYSTEMS

A. The entire piping of the sanitary system and of the storm water system shall be tested with water in accordance with the plumbing code and the Local Plumbing Inspector's requirements and proved tight before the trenches are backfilled or fixtures connected.

B. All drainage and vent systems shall be filled with water and proven tight under a 10'-0" head over new Building Roof for a minimum of two (2) hours, Water level must remain constant through test without adding water.

C. After all fixtures have been permanently connected to the sanitary system and the system is completed, a smoke test shall be applied to the sanitary system, and the entire system proved tight to the satisfaction of the Architect, when filled with smoke under pressure equal to 1" column of water. The smoke shall be produced by a smoke generating machine and not be chemical mixtures.

3.19 ADJUSTMENT AND BALANCING OF DOMESTIC WATER SYSTEM

A. Scope: Balance all domestic hot water and hot water re-circulation systems.

B. Before any adjustments are made:

1. Check temperature control device operation (mixing valves, external temperature control devices, etc.)
2. Check rotation of pumps.
3. Adjust pressure reducing valves.
4. Verify proper operation of ASME pressure and temperature relief valves.

C. Using flow meters, adjust the quantity of water circulated by each pump and the flow in each branch of the hot water re-circulation systems.

3.20 SEQUENCING ILLUSTRATION

A. Reference Section 01 91 00.

END OF SECTION

SECTION 22 08 01

COMMISSIONING AGENT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to section 22 08 00 for commissioning requirements and Division 1 for additional information.

1.2 DESCRIPTION OF THE WORK

A. This Section covers the Scope of Work for the Commissioning Agent (CA) who will be hired by the Owner.

B. The Commissioning Agent shall oversee the commissioning of plumbing systems as described in Section 22 08 00. The CA shall prepare precommissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.

C. The CA shall have authority to direct and schedule tests. The CA shall have no authority to direct changes to the construction of the systems.

1.3 COMMISSIONING PLAN

A. The CA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.4 COMMISSIONING FORMS

A. Review 100% CD's. Provide written summary of how each commissioned item of equipment should operate. Include calculations verifying scheduled capacity.

B. The CA shall develop forms similar to that in Section 22 08 00 for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and proved by the Owner prior to acceptance. Each form shall be signed by the Contractor, CA and Owner prior to acceptance of a system or piece of equipment.

1.5 COMMISSIONED EQUIPMENT

A. All pumps as scheduled

B. Hot water heaters

C. All other scheduled equipment

1.6 COMMISSIONED SYSTEMS

A. All plumbing systems in new and renovated spaces, refer to Section 22 08 00 for additional requirements.

1.7 PROJECT OBSERVATIONS

A. The CA shall perform observations of the commissioned equipment and systems twice a month at a minimum and more as required to keep pace with construction. The CA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and Owner for resolution. The CA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the Owner, Architect and Contractor and shall be part of the final commissioning manual.

1.8 OPERATIONAL AND START-UP TESTS

A. The CA shall witness start-up tests and collect documentation of the tests. The CA shall notify the Architect and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

B. After the Contractor has submitted in writing that the systems are completed, the CA shall schedule and direct operational tests of the systems. These tests shall be as described in Section 22 08 00. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the Architect and Contractor. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

1.9 COMMISSIONING MANUAL

A. The CA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:

1. Design and Energy Codes.
2. Commissioning Plan.
3. Completed Commissioning Forms.
4. Completed Observation Reports.
5. Completed Start-up Reports.
6. System Operational Tests.
7. Final sequence of operation to be achieved.
8. Summary of building operation as commissioned, noting deviations from design.
9. Design Criteria (extended from Design Documents by CA).
10. Written summary of normal startup and operating procedures for each commissioned item of equipment.

The manual shall be a three ring binder with tabs for each section. Provide 5 copies.

END OF SECTION

SECTION 22 10 00

PLUMBING PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract and Division 1 Specification Sections (General Requirements), apply to this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on the following:

1. Water hammer arresters.
2. Roof drains, floor drains, floor sinks, cleanouts and area drains.
3. Downspout nozzles.
4. Water meter and meter pit.
5. Trap primers.
6. Trap guards.
7. Cleanouts.
8. Dissimilar Metals.
9. Pipe Sleeves.
10. Stack Sleeves.
11. Grease interceptor.
12. Thrust Blocks
13. Drip Pans.

1.3 STANDARDS

A. Materials shall comply with the latest editions of the following standards.

1. Plumbing Code of New York State
2. Vassar College Facility Design & Construction Standards
3. Town of Poughkeepsie
4. Cast iron: ASTM A-74-87
5. Cast iron pipe fittings ASTM A-888
6. Cast iron pipe couplings ASTM C-564
7. Copper pipe:
   a. Type K, L, M: ASTM B88
   b. DWV: ASTM B306-88
8. Ductile iron pipe: ASTM A377-89
9. All potable water piping and fixtures should be compliant with NSF-61 requirements for lead free piping
10. All piping shall be domestically manufactured and shall be by the same manufacturer.
11. ANSI/UL 263: Fire test of building construction and materials.

1.4 RELATED WORK

A. Section 22 05 29 Pipe Supports and Anchors.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING AND ACCESSORIES

A. Comply with NSF-61 for lead free potable water piping.

B. Above Ground Inside Building, Size 6" and Under:

1. Pipe: Copper, hard temper, Type L, ASTM B88.
2. Fittings:
   a. Wrought copper, or cast bronze.
   b. ASME B16.22 wrought copper fittings or ASME B16.18 bronze castings with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).
3. Solder:
   a. 95-5 tin antimony (no lead), ASTM B32.

C. Above Ground Inside Building (Mechanical Couplings), Size 6" and under:

1. Pipe: Copper, hard temper, Type L, ASTM B88.
2. Fittings:
   a. ASME B16.22 wrought copper fittings or ASME B16.18 bronze castings with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted.
3. Solder
   a. Couplings shall be Installation-Ready, stab-on design, for direct 'stab' installation onto roll grooved copper tube without prior field disassembly and no loose parts. Housings shall be ductile iron cast with offsetting, angle-pattern bolt pads, coated with copper-colored enamel. Gasket shall be Grade "EHP" EPDM, suitable for hot water up to 250 deg F, and plated steel bolts and nuts.
4. Refer to section 22 05 21 for other acceptable joining methods

D. Above Ground Inside Building, Size 8" and larger:

1. Type L copper.
   a. Grooved mechanical couplings and fittings as described above for 8" size.
2. Stainless steel pipe with mechanical couplings minimum 175 psi WWP.
   a. Stainless Steel Grooved End Fittings: Manufactured of stainless steel conforming to ASTM A403, WPW, WPW/S9, or CR/S9, or shall be fabricated from stainless steel pipe conforming to ASTM A312 with factory grooved ends. Fittings shall be type 316/316L stainless steel.
   b. Mechanical Couplings for Stainless Steel Pipe: Manufactured in two or more segments of cast stainless steel conforming to ASTM A351, A743, and A744, pressure-responsive, synthetic rubber gasket and type 316 stainless steel bolts and nuts conforming to ASTM A193, Grade B8M, Class 2.
      1) Rigid Type: Cast with key designed to clamp the bottom of the groove to provide an essentially rigid joint. Victaulic Style 489.
      2) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 77S.
   c. Ductile Iron Couplings for Stainless Steel Pipe: Two or more segments of cast ductile iron conforming to ASTM A536, designed to clamp the bottom of the groove to provide an essentially rigid joint. Gaskets shall be pressure-responsive, synthetic rubber (UL classified in accordance with ANSI/NSF-61 for hot (180 deg F) and cold (86 deg F) domestic water service) and plated steel bolts and nuts. .

E. Below Ground Inside Building, Size 2" and Under:

1. Pipe: Copper, annealed, Type K.
2. Fittings: Wrought copper, brazed.

F. Below Ground Outside Building, 3" and Over:

1. Ductile pressure pipe, tar coated, cement lined:
   a. Pipe: ANSI A21.51, Class 50.
   b. Fittings: ANSI 21.10.
   c. Rubber Gaskets: ANSI 21.11.

G. Use approved fittings for connections between dissimilar pipe systems.

2.2 PRESS FIT JOINING SYSTEM FOR DOMESTIC WATER PIPING

A. Manufacturer

1. Viega ProPress
2. Elkhart Products, Express

B. Material

1. Press Fittings: Copper press fittings. Must comply with ASME B16.18 or B16.22.
2. O-Rings: EPDM
3. Fittings shall be rated for 0°F to 250°F, and 250 psi.

C. Application

1. Locations where Engineer has determined that traditional hot joining methods are not possible at a specific location. Specific approval for each case required.

D. Press-Connect Fitting: Copper press-connect fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 O-rings for copper press-connect fittings shall be EPDM.

E. Copper press-fittings shall be installed in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and marked at the end of the fittings. The fitting alignment shall be checked against the mark on the tubing to insure the tube is fully engaged (inserted) in the fittings. The joints shall be pressed using a pressing tool and jaws, or jaw set, approved by the manufacturer.

F. Alignment of the correct area on the fittings with the corresponding correct area of a crimping sling is critical.

When the installer has confirmed that positioning and alignments are correct and other proper installations procedures have been followed, crimping can take place with the band remaining in the groove.

Installer shall use manufacturer provided alignment and dimension guides or employ equivalent measures when none are provided by manufacturer.

G. Tools used to complete joint shall be manufacturer approved for the fitting being installed.

2.3 TRAP PRIMERS (TP)

A. Manufacturers:

1. Design basis: PPP as noted in Plumbing Fixture Schedule.
2. Construction: Corrosion resistant brass. "O" rings shall have a flexibility range of -40°F to 450°F.
3. Provide distribution units for connector points as shown on plans.
4. Complies with ASSE STD 1018.

2.4 TRAP GUARDS (TG)

A. Manufacturers:

1. Design basis: ProSet Trap Guard
2. Construction: A flexible tube made of elastmeric material that is treated to roll up when water is passing through drain.
3. Install in floor drains and floor sinks from 2" up to and including 4" as shown on plans indicated with a (TG) behind drain designation.
4. Use of trap guards subject to approval by local authority.

2.5 WATER HAMMER ARRESTER (Shock Absorber)

A. Manufacturers:
1. Design Basis: Zurn Shoktrol Z-1700
2. Construction: Stainless Steel, Bellows
3. Other Acceptable Manufacturers:
   a. Josam
   b. Sioux Chief
   c. J.R. Smith
   d. MIFAB-WHB
4. Standards: PDI WH201, ASSE STD 1010.

B. Install permanently sealed water hammer arrestors on all hot and cold water branches and headers to plumbing fixtures whether it is indicated on the Plumbing Drawings or not.

C. Shock absorbers are to be of size and location in accordance with the manufacturer's recommendations and with DPI Standard WH 201 and shall be PDI approved. Provide accessibility to all shock absorbers.

D. Provide shock absorbers at the top of water risers and at all quick closing valves, solenoid valves and at equipment such as sterilizers, washers, etc.

2.6 WATER METER

A. Water meter to be Neptune or Metron-Farnier and shall be read in cubic feet. Meter to be complete with plate or basket strainers, three valve bypasses and pressure gauge on bypass.

B. Provide meter, pit, and cover in accordance with Water Supplier's standards and instructions.

1. Meter shall be furnished by the Contractor in accordance with Water Supplier's standard specification.

C. Meter shall be located in building or in an exterior pit as indicated.

2.7 SANITARY AND VENT PIPING (WITHIN BUILDING)

A. Above Ground:

1. Cast iron hub and spigot, neoprene gasket.
2. Cast iron no hub, neoprene gasket and stainless steel sleeve joint (as allowed by jurisdiction). ASTM A888, CISPI 301.

B. Underground:

1. Cast iron hub and spigot, with oakum packing and caulked molten lead in one continuous pour or neoprene gaskets. ASTM A74.

C. Underground (outside the building):

1. SDR 35 PVC, with solvent welded joints. ASTM D 1784, ASTM D 3034, ASTM D 3212, ASTM F 477. "FERNCO" connection are NOT allowed.

2.8 HEAVY DUTY NO HUB COUPLINGS

A. Use on the following:

1. Sanitary vent piping 4" and larger.
2. Sanitary piping 3" and larger.
3. All storm piping.

B. 1-1/2", 2", 3" and 4": 3" wide 304 stainless steel shield; (4) minimum stainless steel clamps; fixed and "floating" eyelet.

C. 5" and over: 4" wide 304 stainless steel shield, with six (6) stainless steel clamps mounted in series.

D. Torque to minimum 80 inch pounds or per manufacturer's recommendation.

E. Acceptable manufacturers: Husky Series 4000 or Mission Heavy Weight.

2.9 STANDARD DUTY NO HUB COUPLINGS

A. Standard duty couplings shall conform to CISPI 310-85: 0.008" thick corrugated stainless steel. ASTM A888.

B. Use of the following:

1. Sanitary vent piping up to and including 3" piping.
2. Sanitary piping up to and including 2" piping.
3. As allowed by jurisdiction.

C. Torque to inch pounds per manufacturer's recommendation.

D. Acceptable manufacturers: Tyler, Mission, AB&I, Clamp All, Huskey.

2.10 PUMPED SANITARY PIPING (ABOVE & BELOW GRADE)

A. 125 lb. galvanized steel, threaded.

B. Galvanized ductile iron grooved pipe fittings, designed for cut grooved joint.

1. Grooved End Fittings: ASTM A536 ductile iron or ASTM A53 forged or fabricated carbon steel, galvanized in accordance with ASTM A153.
2. Grooved Mechanical Couplings: Two ASTM A 536 ductile iron housings, galvanized to ASTM A153. Pressure-responsive, synthetic rubber gasket, Grade "T" Nitrile suitable for pumped sanitary piping, and plated steel bolts and nuts.
   a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9.
      1) 2" through 8" Sizes: "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 107H QuickVic.
      2) 10" and 12" Sizes: Standard rigid coupling. Victaulic Style 07 Zero-Flex.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required.

1) 2" through 8" Sizes: "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic.
2) 10" and 12" Sizes: Standard flexible coupling. Victaulic Style 75 and 77.

C. Hub and spigot or no hub couplings are not allowed.

2.11 SOIL AND VENT PIPING ACCESSORIES

A. Use approved fittings for connections between dissimilar pipe systems.

B. Acceptable Manufacturers:
1. Josam
2. Wade
3. Zurn
4. J.R. Smith
5. Jones Spec
6. Watts Ancon

C. Cleanout Plugs:

1. Material: Cast bronze or brass.
2. Type: Countersunk.
3. Threads: ANSI B2.1.

D. Wall Cleanout Covers:

1. Type: Frameless, round, low profile plate.
2. Material: Stainless steel or chrome plated brass.
3. Attachment: Single exposed flush screw.
4. Finish:
   a. Non-painted surfaces: Bright polished.
   b. Surfaces to be painted: Prime coat.

E. Floor Cleanouts:

1. Body: Standard round Duco cast iron.
2. Attachment: Bronze screws.
3. Sleeve: Full thickness of floor slab.
4. Top:
   a. Shape:
      1) Where floor covering has rectangular pattern: Square.
      2) Other areas: Round.
5. Cover:
   a. For Vinyl Tile and Similar Floor Coverings: Recessed to receive inset of floor material.
   b. For carpeted floor covering provide carpet cleanout marker.
   c. Other areas: Nickel bronze scoriated finish.

F. Exterior Cleanouts to Grade:

1. Material: Duco cast iron.
2. Ferrule: Caulk type.
3. Plug: Cast bronze countersunk type.

G. Vandal-Proof Caps

1. Material: Duco cast iron.
2. Attachment: Recessed Allen set screw.

H. Backwater Valve:

1. Body: Duco cast iron.
2. Valve: Bronze.
3. Provide cleanout cover.
    a. Locate in accessible manhole.

2.12 SANITARY SEWER PIPING (BELOW GRADE-EXTERIOR TO BUILDING)

A. Match material and methods specified in Division 33 for sitework sanitary sewer system or as listed below.

B. Use approved fittings for connections between dissimilar pipe systems.

C. Ductile iron bell and spigot.

2.13 STORM WATER PIPING (INSIDE BUILDING)

A. Above Ground:

1. Cast iron, hub and spigot, neoprene gasket joints.
2. Cast iron no hub, neoprene gasket and heavy duty no hub couplings.

B. Underground:

1. Cast iron hub and spigot, with oakum packing and caulked molten lead in one continuous pour or neoprene gasket.
2. Cast iron, hub and spigot, neoprene gasket joints.

2.14 STORM WATER PIPING (BELOW GROUND-EXTERIOR TO BUILDING)

A. Match material and methods specified in Division 33 for sitework storm sewer system or as listed below.

B. Match materials and methods specified for sanitary sewer piping above.

C. Use approved fittings for connections between dissimilar pipe systems.

2.15 STORM DRAINAGE PRODUCTS

A. Roof Drain: (RD)
1. Material: Cast Iron
2. Dome: Cast Iron
3. Include:
    a. Combined flashing collar and gravel stop.
    b. Extension for insulation.
    c. Under-deck clamp.
    d. Sump receiver.
    e. Expansion joint.

B. Overflow Roof Drain: (OD)
1. Same as Roof Drain Type 1 except:

a. Provide removable water dam. Top of water dam shall be 4” above low point of roof.
2. Provide (1) overflow roof drain for every roof drain shown.

C. Downspout Nozzle
1. Material: Cast Bronze
2. Manufacturer: Zurn
3. Model: 1770

D. See Plumbing Fixture Schedule and Plumbing Fixture specification for additional information.

2.16 GREASE INTERCEPTOR

A. Materials:

1. Pre-formed or cast concrete.

B. Capacity: See plans.

C. Design:

1. Comply with the Town of Poughkeepsie.
2. Two compartment.
3. Two access manholes with ladders and manhole covers. Covers to be cast with “Sewer”.
4. See detail shown on plans for general requirements.

2.17 DISSIMILAR METALS

A. Connections between pipe, fittings, hangers and equipment of dissimilar metals shall be insulated against direct contact one with the other, by using a high quality or grade of dielectric insulated material

B. Dielectric unions or insulated couplings shall be installed between copper or brass piping material and steel piping material or steel tanks. Unions or insulated couplings shall be used for pipe sizes 2” and smaller, and dielectrically gasketed flanges and sleeves for pipes 2-1/2” and larger.

C. Dielectric fittings shall be installed between copper and steel piping systems to prevent galvanic corrosion. Body shall be ductile iron or steel, zinc electroplated, with LTHS high temperature, polyolefin polymer lining and grooved or threaded ends. Victaulic Style 47.

2.18 PIPE SLEEVES

A. Any pipe required in walls and floors shall be provided with a pipe sleeve.

B. Provide watertight sleeves for all pipes penetrating exterior foundation walls and waterproof floor areas and where such areas are noted on the Architectural and Structural Drawings.

C. Except where indicated or specified otherwise, provide and install Schedule 40 galvanized steel sleeves for all piping passing through concrete walls or floor slabs. Sleeves shall be securely set in the framework and where not specified otherwise shall be of such length as to extend flush with each face of the wall in which they are installed, 3" above unfinished floor and 2" above the finished floor or tile, as applicable. Sleeves in kitchen and laundry areas shall be chrome plated.

D. Sleeves shall have an internal diameter of at least 1" larger than the outside pipe size diameter of the pipe passing through them. Sleeves in exterior foundation walls shall be James B. Clow and Sons, No. F-1430 or F-1435, or approved equal, extra-heavy cast iron wall sleeves with intermediate integral flange. Cast iron wall sleeves with intermediate integral flange. Cast iron sleeves shall be set with end flush with wall faces.

E. Where sleeves penetrate waterproofing, install caulking between pipes and pipe sleeves as follows:

1. Pack oakum to a depth of 1" between pipe and pipe sleeve at a location permitting 3" of sealant to be installed above the oakum.
2. Fill space above oakum to a depth of 3" with sealant similar and equal to Igas Joint Sealer as manufactured by Silka Chemical Corporation.

F. Sleeves for gas piping shall extend 4 inches beyond exterior face of wall and 1 inch beyond inner face.

G. Sleeves in waterproof floors shall be as manufactured by Zurn Inc. or equal, cast iron sleeve with integrally cast flange and flashing device.

2.19 STACK SLEEVES

A. Stack sleeves for pipes passing through roof shall be equal to Zurn Z-195-10 or MIFAB R1900 with cast iron body, adjustable flashing ring, rust resistant bolts, and under deck clamp. The adjustable flashing ring shall be caulked after it is in the proper position. The space between the flashing sleeve and the pipe passing through same shall be caulked watertight.

2.20 CLEANOUTS

A. Provide easily accessible cleanouts at base of vertical stacks and leaders; at ends of horizontal drainage lines and at intervals not exceeding 50 ft.; at each change of direction; on hand holes of running traps; and where indicated to make entire drainage system accessible for roding. Provide at least 18 inch clearance to permit access to cleanout plugs.

B. Cleanouts for cast iron pipe shall consist of tapped extra heavy cast iron ferrule caulked into cast iron fittings, and extra heavy brass screw plug with solid hexagonal nut.

C. Cleanouts turning out through walls and up through floors shall be made by long sweep ells of "Y" and 1/8 bends with plugs and face or deck plates to conform to architectural finish in room. Where no definite finish is indicated on the Architectural and/or Mechanical Drawings, wall plates shall be chrome plates cast brass and floor plates shall be nickel bronze. Screws in cleanouts in finished areas shall be vandal-proof.

D. Cleanouts shall be full size at the pipe up to 6" inclusive. On larger size piping 6 inch size plugs shall be used.

E. The following list indicates the various types of cleanout desired at various locations indicated on the Drawings. These cleanouts have been selected from the catalog of Zurn and are representative of quality design and finish desired. Cleanouts of Josam Mfg. Co., or J.R. Smith, or MIFAB, or approved equal may be submitted provided they meet fully in every respect (such as material, weight, clamping features, finish, etc.). The characteristics and quality of the cleanout shall be as follows.

1. Cleanout fitting in vertical stacks shall consist of tapped tees, capable of receiving a rough brass raised head cleanout plug; Zurn 1460-8 or MIFAB #C-1400S-9.
2. Cleanouts in Mechanical Equipment Room shall be Zurn 1420-25 or MIFAB #C1100 XR-4-Z.
3. Cleanouts in finished areas shall be Zurn Z-1420-3 or Z-1400HD or MIFAB #C1100 TS-1 with recess for tile floors.
4. Cleanouts in Dex-O-Tex waterproof floors shall be Zurn No. Z-1405-18 or MIFAB #C1100XR-4-Z with extra heavy duty top.
5. Cleanouts for 3 or more fixtures piped horizontally shall be extended to wall cleanouts, and shall be Zurn No. Z-1470 or MIFAB #C1430.

F. All cleanout plugs shall be brass and lubricated with graphite before installation.

G. Cleanouts will not be allowed to be located in inaccessible locations.

2.21 DRIP PANS

A. In so far as possible, piping shall not be installed within the ceiling or exposed in operating and delivery rooms, nurseries, food preparation centers, food serving facilities, food storage areas, central services, electronic data processing areas, electric closets, and other sensitive areas.

B. When overhead piping in these areas in unavoidable, provide aluminum drip pans with indirect waste extended and spilled to a safe place.

2.22 DOMESTIC WATER PIPING – PEX – DEDUCT ALTERNATE (ONLY IF ACCEPTED BY OWNER AND ENGINEER)

A. Contractor shall submit a deduct alternate for the use of PEX for domestic for domestic hot and cold water piping 1" and smaller.

B. Additional Reference Standards:

1. ASTM F1807: specification for metal insert fittings utilizing a copper crimp ring for SDR9 cross-linked polyethylene (PEX) tubing
2. ASTM F2023: test method for evaluating the oxidative resistance of cross-linked (PEX) tubing and systems to hot chlorinated water.
3. ASTM F2159: specification for plastic insert fittings utilizing a copper crimp ring for SDR9 cross-linked polyethylene (PEX) tubing
4. ASTM F3347: Standard Specification for Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing
5. ASTM F3348: Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing
6. ASTM F876: specification for cross-linked polyethylene (PEX) tubing
7. ASTM F877: specification for cross-linked polyethylene (PEX) plastic hot and cold water distribution systems.
8. AWWA C904: cross-linked polyethylene (PEX) pressure pipe, ½ in. (12 mm) through 3 in. (76 mm), for water service
9. CAN/ULC S102.2: standard method of testing for surface burning characteristics of flooring, floor covering and miscellaneous materials and assemblies.
10. CSA CAN/CSA B137.5: cross-linked polyethylene (PEX) tubing systems for pressure applications.
11. Viega PureFlow System Engineering Specifications
12. NSF 14: plastic piping component and related materials
13. NSF 61: drinking water system components – health effects

C. Project Conditions:

1. The location of a manifold with valves shall be accessible and in an area not subject to freezing. Proper support of the manifold shall be provided.

2. PEX tubing and manifolds shall not be left exposed in direct sunlight for extended periods of time – short periods not exceed 15 days.

D. Manufacturer

1. Viega LLC

E. All PEX piping shall be insulated per specification section 220700, no expections.

F. Only straight lengths of PEX tubing/piping will be accepted, the use of roll/coil type is not acceptable.

G. Material

1. Tubing Standard: Viega PureFlow PEX high-density cross-linked polyethylene tubing shall be manufactured to the requirements of ASTM F876 and meet the standard grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/03. The following three standard grade ratings are required:
   - 200 degrees F (93 degrees C) at 80 psig (551 kPa)
   - 180 degrees F (82 degrees C) at 100 psig (689 kPa)
   - 73.4 degrees F (23 degrees C) at 160 psig (1102 kPa)

   a. Chlorine testing: According to ASTM F876 shall meet or exceed the following end use condition.
      1) End use conditions of : 100% @ 140°F. Per PEX 5306 (CL5).
   b. UV testing: According to ASTM F876 PEX tubing products shall meet or exceed the following exposure limits.a. Viega PureFlow PEX 6 month

2. Fitting Standard: PureFlow Press fittings shall be manufactured from UNS, C87700, C87710 Bronze or Radel R® polymer, meeting the requirements of ASTM F877 and ASTM F3347 (metallic) or ASTM F3348 (polymer) tested as a system with Viega PureFlow PEX tubing. The PureFlow Press sleeve shall be manufactured out of a 304 grade or better stainless steel and have three view holes (attached sleeve) to ensure proper PEX tubing insertion. The attached sleeve fitting will incorporate a tool locator ring that shall be in place while making a proper press connection. The PureFlow Press connection shall be made with a Viega supplied ratcheting PureFlow Press hand tool or PureFlow Press power tool.

3. Manifolds:

   a. Copper Manifolds: Shall be copper material having a male or female solder, ProPress or PureFlow Crimp inlets. All outlets shall be PureFlow Press, PureFlow Crimp or ProPress fittings. Shall be provided by the Cross-linked Polyethylene system manufacturer.
   b. Provide access door as required to provide access to manifolds.

4. Adapter Fittings: PEX adapter fittings shall conform to one of the following ASTM standards; F877, F1807, F2159, or ASME B1.20.1 and be listed to the CSA B137.5. The adapter fittings shall mate to NPT threads, copper tubing, copper fittings or ProPress fittings.

H. Source Quality Control

1. The PEX tubing and fitting manufacturer shall maintain a third party listing of the tubing and fittings. The tubing and fittings shall be certified in accordance with ANSI/NSF 14/61 to verify suitability to transport potable water. The tubing and fittings shall have the mark “NSF-pw”, “cNSF® us pw-G”, or “NSF 61” permanently marked on the product to verify the material listing.

2. The manufacturer of the PEX tubing and fittings shall maintain a quality control program in accordance with ISO 9001 or NSF International in the manufacturing plant to assure that the tubing and fittings are continually being produced to the required standard. The tubing and fittings shall be certified as complying with NSF 14.

PART 3 - EXECUTION

3.1 GENERAL

A. Testing: Test in accordance with the applicable Plumbing Code.

B. Connections to Equipment Furnished Under Other Sections:

1. Make final connections to all equipment shown on drawings as connected to supply and/or drain piping.
2. Furnish all devices necessary for final connection, including:
   a. Tail pieces

b. Stops
c. Supplies

C. Corrosion Protection:

1. Provide isolation between concrete or mortar and any copper pipe.
2. All below grade piping shall be adequately protected from corrosion.

D. Comply with Section 22 05 29 Pipe Supports and Anchors for pipe support requirements.

3.2 INSTALLATION OF DOMESTIC WATER PIPING AND PRODUCTS

A. Install all horizontal water piping level and parallel to building construction (except piping noted to be drained down slope toward drain at 1/8" /ft. min.). Make any changes in direction with fittings, don't kink or bend. All vertical piping to be plumb. Provide dielectric isolation between uninsulated pipe and hangers. Provide plastic grommets when going through metal studs. Tape is not acceptable for dielectric isolation.

B. Water Hammer Arrestors: Install arresters as shown on the drawings and as described in this specification. At minimum any branch line connected to a flush valve shall have one arrestor.

C. Disinfection:

1. After installation of all fixtures served, fill all domestic water lines with a chlorine-water solution of 50 parts per million minimum.
2. Hold solution in pipe for at least 24 hours.
3. Open and close all valves 3 times during chlorination.
4. Waste chlorine solution from each outlet.
5. Measure solution at end. If not 10 ppm, repeat.

D. Meters:

1. Install water meter in accordance with Water Supplier's standard.

E. It is the intent that each part of the plumbing systems shall be complete in all details and all lines provided with all control valves as indicated on Drawings, or as may be required for the proper control of the pipe lines under this Section so that any fixture, line or piece of apparatus may be cut out for repair without interference or interruption of the service to the rest of the building.

F. The Contractor shall examine carefully the architectural plans and details and familiarize himself with all conditions relative to the installation of piping, particularly where same is concealed behind furring or in hung ceilings. In no case shall the Contractor permit his pipes to be exposed beyond finished plaster lines unless specifically shown on Drawings. He shall consult with the other trades in the building and install his piping in such a way as to least interfere with the installation of other trades. All piping installed in finished areas shall be completed concealed within hung ceilings, furrings, soffits, pipe spaces.

G. The water piping shall all be installed so as to drain, and branches shall not be trapped, but shall have continuous pitch. Where necessary to raise or lower mains, the same shall be provided with a drip and shall be properly valved and capped.

H. Piping shall be installed, whether indicated or not, so as to rise and/or drop to clear any and all conduits larger than 1", lighting fixtures, ductwork and heating mains, to maintain the desired clear heights. The Contractor shall consult with the other trades and facilitate the erection of the equipment and piping.

I. Run piping straight and as direct as possible, in general forming right angles with or parallel to walls or other piping. Risers shall be erected plumb and true.

J. After cutting, all pipes shall be reamed out to full bore and before erection the inside of all pipes shall be thoroughly cleaned.

K. No piping or work shall be concealed or insulated until all required tests have been satisfactorily completed and work has been approved by the Architect and all other authorities having jurisdiction.

L. Expansion loops and anchors shall be provided on all hot water and hot water circulation mains. Expansion loops shall be made with four elbows and three lengths of pipe, except as otherwise noted on the drawings. All loops shall be prestressed.

M. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.3 PRESS FIT SYSTEMS

A. Fittings and piping shall be joined in accordance with manufacturer’s installation guidelines.

1. Tubing shall be fully inserted into fitting.
2. Mark all tubes at shoulder of fitting.
3. Press joints using manufacturer approved tool.

B. All press fit systems shall have a preliminary water pressure test at 50 psi to confirm all fittings are properly pressed. This test is in addition to the that required by the system.

3.4 INSTALLATION OF SANITARY AND VENT PIPING

A. Couplings: Apply standard and heavy duty couplings as specified.

B. Gaskets: Install gaskets in accordance with manufacturer’s recommendations for the use of lubricants, cements, and other special installation requirements.

C. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.

D. Cleaning Piping:

1. Clear the interior of pipe of dirt and other superfluous material as the work progresses.
2. Place plugs in the end of uncompleted pipe at the end of the day or whenever work stops.

E. Test Plugs:

1. Provide test plugs in floor drains and roof drains at the time of installation.
2. Leave test plugs in place for the duration of construction until sewer or drainage system is complete.

F. Expansion:

1. Provide a vertical expansion joint at each connection to roof drain unless an offset is provided.
2. Where piping crosses building expansion joints, provide expansion joints to allow for building movement.
3. Refer to Section 22 30 00 for additional requirements.

G. Vent Flashing:

1. Provide 4 lb. sheet lead (24” x 24” minimum).
2. Extend lead 5” above the vent and turned down into vent pipe.

H. Vent Location: Do not install vents within 2 ft. of roof edge, parapet, wall line, or an “on-the-roof structure” and within 10 ft. of any air intake.

I. Do not support interior grease, sand or oil interceptors from floor extension. Provide supplemental support structure.

J. The size of storm, soil, waste, water, and vent piping shall be as determined by the local rules and regulations for plumbing and drainage, except where specifically noted to be larger by the Specifications or plans; and all fixed rules of installation as set forth in the Rules and Regulations shall be followed as part of the Specifications.

K. The Contractor shall examine carefully the architectural plans and details and familiarize himself with all conditions relative to the installation of piping, particularly where same is concealed behind furring or in hung ceilings. In no case shall the Contractor permit his pipes to be exposed beyond finished plaster lines unless specifically shown on Drawings. He shall consult with the other trades in the building and install his piping in such a way as to least interfere with the installation of other trades. All piping installed in finished areas shall be completed concealed within hung ceilings, furrings, soffits, pipe spaces, etc.

L. Branch connections of the drainage systems shall be made with "Wye" and long "Tee-Wye" fittings, short 1/4" bends, common offsets and double hubs will not be permitted. Short "Tee-Wye" fittings are to be used in vertical piping only.

M. Piping shall be installed, whether indicated or not, so as to clear any and all conduits, lighting fixtures, ductwork and heating mains, to maintain the desired clear heights. The Contractor shall consult with the other trades and facilitate the erection of the equipment and piping. Gravity systems shall have priority.

N. Run piping straight and as direct as possible, in general forming right angles with or parallel to walls or other piping. Risers shall be erected plumb and true.

O. After cutting, all pipes shall be reamed out to full bore and before erection the inside of all pipes shall be thoroughly cleaned.

P. No piping or work shall be concealed or insulated until all required tests have been satisfactorily completed and work has been approved by the Architect and all other authorities having jurisdiction.

Q. Cleanouts shall be provided at foot of all stacks, all changes of directions, at the ends of branch runs where shown, every 50'-0" and as required by Code, and shall be terminated as described under cleanouts.

R. The house drains must be run at a minimum grade of 1/8" per foot downward in the direction of flow. Wherever possible, a 1/4" per foot pitch shall be maintained. Branch connections to stacks from fixtures shall pitch 1/4" per foot where possible. Attention is again called to the necessity of maintaining the ceiling heights established. All piping installed in finished areas shall be completed concealed within hung ceilings, furrings, soffits, pipe spaces, etc.

S. Furnish and install complete systems of ventilating pipes from the various plumbing fixtures and other equipment to which drainage connections are made. Ventilating pipes shall be connected to the discharge of each trap and shall be carried individually to point 6” above the ultimate overflow level of the fixture before connecting with any other

vent pipe; in general, this will be approximately 3'-6" above the finished floor. Branches shall be arranged to pitch back to fixtures.

T. The individual vent pipes shall be collected together in branch vent lines and connected to vent stacks, in general paralleling soil and waste stacks. Wherever possible, vent stack offsets shall be made with 45 degree fittings. The heels of vent stacks shall be connected to adjacent soil stacks for purpose of draining condensation where possible. The waste of a fixture shall be connected to the base of each vent stack for the purpose of washing out any scales or dirt which may accumulate, or the soil stack shall be used to wash out the heel of the vent.

U. The tops of all soil and waste stacks shall be extended as additional ventilating pipes. The tops of all ventilating stacks shall run independently through the roof. Pipes smaller than 4" size shall be increased to 4" by means of approved increasers before passing through the roof slab.

V. Vent piping sized less than 1½" will not be allowed, even if shown on the drawings or permitted by Code.

W. All open vent pipes that extend through a roof shall be terminated at least 24 inches above the roof, except that where a roof is to be used for any purpose other than weather protection or maintenance, the vent extension shall be run at least 7 feet above the roof.

3.5 INSTALLATION OF STORM DRAINAGE PIPING (ABOVE GROUND WITHIN BUILDING)

A. Couplings: Use heavy-duty couplings on all no hub storm piping above grade. Do not use no hub couplings on piping more than 20 feet below the drain fixture unless offsets are made down through buildings in no more than 20 feet increments. Utilize galvanized steel pipe with screwed or grooved mechanical fittings.

B. Gaskets: Install gaskets in accordance with manufacturer's recommendations for the use of lubricants, cements, and other special installation requirements.

C. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.

D. Cleaning Piping:

1. Clear the interior of pipe of dirt and other superfluous material as the work progresses.
2. Place plugs in the end of uncompleted pipe at the end of uncompleted pipe at the end of the day or whenever work stops.

E. Test Plugs:

1. Provide test plugs in floor drains and roof drains at the time of installation.
2. Leave test plugs in place for the duration of construction.

F. Roof Drains:

1. Install drains on the center line of roofing reinforcement.
2. Clamp flashing into drain flashing collar.
3. Install domes immediately after completion of roof installation.

G. Expansion:

1. Provide a vertical expansion joint at each connection to roof drain unless an offset is provided.
2. Where piping crosses building expansion joints, provide expansion joints to allow for building movement.
3. Refer to Section 22 30 00 for additional requirements.

H. Downspout Nozzles: Install with flange secured to wall at base of concealed storm leaders that discharge through the building wall above grade.

I. Cleanouts shall be provided at foot of all stacks, all changes of directions, at the ends of branch runs where shown, every 50'-0" and as required by Code, and shall be terminated as described under cleanouts.

J. The house drains must be run at a minimum grade of 1/8" per foot downward in the direction of flow. Wherever possible, a 1/4" per foot pitch shall be maintained. Branch connections to stacks from fixtures shall pitch 1/4" per foot where possible. Attention is again called to the necessity of maintaining the ceiling heights established. All piping installed in finished areas shall be completed concealed within hung ceilings, furrings, soffits, pipe spaces, etc.

K. Piping shall be installed, whether indicated or not, so as to clear any and all conduits, lighting fixtures, ductwork and heating mains, to maintain the desired clear heights. The Contractor shall consult with the other trades and facilitate the erection of the equipment and piping. Gravity piping shall have priority.

L. Run piping straight and as direct as possible, in general forming right angles with or parallel to walls or other piping. Risers shall be erected plumb and true.

M. After cutting, all pipes shall be reamed out to full bore and before erection the inside of all pipes shall be thoroughly cleaned.

N. No piping or work shall be concealed or insulated until all required tests have been satisfactorily completed and work has been approved by the Architect and all other authorities having jurisdiction.

O. Branch connections of the drainage systems shall be made with "Wye" and long "Tee-Wye" fittings, short 1/4" bends, common offsets and double hubs will not be permitted. Short "Tee-Wye" fittings are to be used in vertical piping only.

P. Connection to roof drain shall be installed in conjunction with the roofing called for under another Division or Section of these Specifications and at such times as designated by this Contractor, so that the building is adequately protected during construction from damage by storm water. All piping shall be adequately and properly supported, and all joints shall be made up as hereinafter specified.

3.6 INSTALLATION OF SANITARY SEWER AND STORM WATER PIPING (EXTERIOR TO BUILDING)

A. Couplings: See Part 2 for use of couplings.

B. Lay piping true to the grades and alignment indicated with unbroken continuity of invert.

C. Install gaskets in accordance with manufacturer’s recommendations for the use of lubricants, cements and other special installation requirements.

D. Install cast iron hub and spigot pipe under roads and paved areas.

E. Clear the interior of piping of dirt and other superfluous material as the work progresses. Maintain a swab or drag in the line and pull past each joint as it is completed.

F. Place plugs in the end of uncompleted conduit at the end of the day or whenever work stops. All taps on active systems must be completed during the same day started.

G. Flush lines if required to remove collected debris.

H. Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.

I. Grout joints between cast iron pipe and concrete pipes thoroughly with cement mortar to make watertight joint.

J. Inspect conduit to determine whether line displacement or other damage has occurred. Make inspection after lines between manholes, or manhole locations, have been installed and approximately 2 ft. of backfill is in place and at completion of the project.

K. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, take whatever steps are necessary to correct such defects to the satisfaction of the Architect/Engineer.

L. Set grade cleanouts located in unpaved and asphalt paved areas in 12” x 12” x 4” concrete pad by this contract.

M. After trench has been excavated in accordance with these Specifications, pipes shall be carefully lowered by suitable rigging and placing as herein provided. Pipe shall not be rolled into trench.

N. The Contractor shall plug or cap any remaining open ends which result from the removal of existing pipe which is to be abandoned. The open ends shall be plugged or capped with cast iron plugs or caps. Live ends of pipe shall be plugged or capped and backed with concrete to provide sufficient bearing equal to the pressure in the pipe times the area of the pipe as directed by the Architect.

O. All water lines shall have at least 4'-0" cover at all points. These depths shall be increased where necessary for making connections or for avoiding subsurface structures, drainage, sewer or other facilities.

P. Piping shall be properly aligned, graded and supported. Piping shall be of correct lengths to permit the joints to be made up without springing or forcing. Change in direction shall be made by use of fittings. Piping shall not be deflected from a straight line at joints in either horizontal or vertical plane, except as authorized by the Architect, and not to exceed the recommendations of the manufacturer.

Q. The Contractor shall make all crossing as required by conditions encountered during construction at no additional expense to the Owner, including, but not limited to telephone conduits, cold water distribution, electric service, sanitary sewers, storm water drains and steam tunnels.

R. The work includes providing material and labor for the installation of elbows, tees, short lengths of pipe, concrete thrust blocks, concrete encasement or supports and such other incidentals which will provide an adequate clearance from an existing utility line and/or sufficient cover.

S. The Contractor shall be responsible for all damage to utilities and repair same at his own expense to the satisfaction of the Architect.

T. Provide vertical and horizontal separation between new sewers and water mains in accordance with Codes and Standards requirements.

U. Reaction or thrust backing shall be applied at all bends, tees, reducers, plugs, caps, valves and dead ends for the water main. Size and shape of concrete backing shall be as approved by the Architect, but in any case shall be sufficient to provide bearing equal to the pounds of pressure multiplied by the area of the pipe.

V. Backing shall be of concrete and shall be placed between solid ground and the fitting to be anchored. Backing shall be placed so that the pipe and fitting joints will be accessible for repair, unless otherwise directed by the Architect. Provide tie rods set into concrete.

W. From the center line of the pipe to a depth of one foot above the top of the pipe, the trenches shall be backfilled by hand with approved materials placed in 3 inch layers and hand tamped to compaction.

X. The Contractor for construction, excavation and demolition operations at or near underground facilities shall use Industrial Code 53 of Title 12, Rules and Regulations of the State of New York, to verify and/or locate existing utilities in the area of the proposed new utility services. The telephone number to contact Code 53 in New York State is 1-800-245-2828.

Y. At the completion of all new buried piping, the contractor shall provide a video of the interior of all of the new piping to verify integrity of joints.

3.7 THRUST BLOCKS

A. This Work shall cover the installation of concrete thrust blocks as shown on the plans or as required.

B. Thrust blocks shall be composed of concrete aggregates meeting ASTM Specification C-33 and Portland Cement meeting ASTM Specification C-150 Portland Cement or C-175 for Air Entrained Portland Cement. Mix shall not be leaner than 1 cement, 2-1/2 sand, 5 stone, having a compressive strength of not less than 200 psi in 36 hours when using high early cement and 7 days when using standard cement.

C. Thrust blocks shall be applied or ordered at bends, tees and hydrants where changes in pipe diameter occur at reducers or in fittings.

D. Thrust blocks shall be placed between solid ground and the fittings to be anchored. The area of bearing on fitting and on ground in each instance shall be that required by the Architect. The concrete shall be placed so that the pipe and fitting joints will be accessible for repair unless otherwise directed by the Architect.

3.8 PIPE ROUTING VERIFICATION

A. All drainable fixtures must have verification of proper routing.

B. Verification must be performed on all new construction and when existing systems are modified.

C. Verification must include positive identification using tracer dyes. Vassar College Customer Service must be notified prior to using dyes.

D. Vassar College personnel or a designated representative must witness verification testing.

E. Documentation of the dye test verification must be presented to Vassar College Environmental Health & Safety Office (EH&S). Forms are available from EH&S upon request.

3.9 TRAP PRIMERS

A. Install all trap primers and required distribution units as shown on plans and as required by manufacturers recommendations.

3.10 TRAP GUARDS

A. Install elastomeric trap guards in specified floor and sink drains as indicated on plans.

3.11 WARNING TAPE AND TRACER WIRE

A. Tracer Wire - #12 HMW-PE yellow jacket, 45 mil solid copper shall be installed to enable electronic locating of the utility.

B. Warning Tape

1. Colored plastic or metalized, installed 12 to 18 inches above all Utilities, but no less than 6 inches below grade.

2. Where required, use warning tape: (per AIA MssterSpec) Acid – and alkali-resistant Polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils this, continuously inscribed with a description of the utility.

3. Tape Colors: Provide tape colors to utilities as follows:

Red: Electric

Yellow: Gas, oil, steam, and dangerous materials

Orange: Telephone and other communications.

Blue: Water systems

Green: Sewer systems

3.12 NON-CONDUCTIVE PIPING PROTECTION

A. Tracer Wire

1. A tracer wire shall be taped to the top center of all direct buried nonconductive utilities. This type of utility shall include, but not limited to, all plastic or FRP Pipes or conduits. This Specification also applies to storm drain and sanitary sewer pipes that do not run a straight line and/or both ends are not visible from the surface.

2. The tracer wire shall be terminated at a readily accessible location, reachable from above ground, and shall not be beyond reach in a confined area.

B. Warning Tape

1. In addition to the tracer wire all direct buried utilities must have a plastic warning tape. (See paragraph 3.10 above).

3.13 PEX SYSTEMS (ONLY WHERE APPROVED BY OWNER AND ENGINEER)

A. The installing contractor shall carefully examine the PEX tubing for defects, cuts, abrasions, cracks, fading color, or blemishes. There shall be no cracks or heavy deformations of the tubing. Fittings and manifolds shall be checked for any signs of abuse. Any damaged tubing or fittings shall be rejected.

B. Preparation

1. Viega PureFlow PEX tubing: Cross-linked polyethylene tubing shall be cut with a PEX tubing cutter. The tubing shall be cut squarely and neatly to permit a proper connection between the tubing and fitting.

C. Installation

1. Pressure rating: Install components having a pressure rating equal to or greater than the system operating pressure.

2. Install PEX tubing that is free of blemishes, cuts, gouges, kinks or noticeable fading of color.

3. Changes in direction: Install fittings for all changes in direction. PureFlow Press connections: PureFlow Press fittings shall be made in accordance with the manufacturer's installation instructions. The Stainless press sleeve shall be placed over the end of the squared off PureFlow PEX tubing while fully inserting the fitting barb into the tubing. Full tubing insertion shall be verified by a visual confirmation of PEX being present through the view holes before engaging a press connection. Full insertion for an attached sleeve connection means tubing must be completely visible in at least two view holes and partially visible in the final view hole. The PureFlow Press connection shall be made with a Viega supplied ratcheting PureFlow Press hand tool or PureFlow Press power tool.

4. Threaded joints: Threaded joints shall have a potable water listed joint sealant tape applied to the male threads only. Tighten joint with a wrench and backup wrench as required.

5. PEX tubing protection: Protect PEX tubing from exposure to direct and indirect sunlight exposure. PEX tubing shall be stored under cover, shielded from direct and indirect sunlight when material is stored for any length of time.

6. Penetration protection: Provide allowance for thermal expansion and contraction of PEX tubing passing through a wall, floor, ceiling or partition by wrapping with pipe insulation, or by installing through an appropriately sized sleeve. Penetrations of fire resistance rated assemblies shall maintain the rating of the assembly.I

7. Horizontal support: PEX tubing must be supported every 32" horizontally with Viega approved suspension clips or plastic insulators.

8. Vertical support: PEX tubing must be supported at each floor or ceiling penetration and every four feet in between.

END OF SECTION

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data for the following:

1. Domestic water heaters.
2. Domestic hot water storage tanks.
3. Pumps.
4. Sump Basins.
5. Warranty and service policies.
6. Escutcheons.
7. Traps.
8. Thermostatic mixing valve.
9. Unions.
10. Laundry Mate.
11. Hose Bibbs.
12. Wall Hydrants.
13. Thermometers.
14. Pressure Gauges.
15. Vacuum Breakers.
16. Fixed air gaps.
17. Hot water mixing valve station.
18. Flow control fittings.
19. Drains.
20. Thrust Blocks.
21. Manhole frames and covers.
22. Catch-basins and covers.
23. Tie-rods.
24. Water Meter(s)

1.2 WARRANTY

A. Water Heater and Storage Tank:

1. Furnish a certificate of warranty outlining heater manufacturer's lining warranty.
2. The warranty shall not be on a pro-rated basis.
3. The heater will have a five year service policy including labor, which will cover replacement labor and freight costs under certain conditions.
4. Initiation and/or continuation of warranty coverage shall not be dependent upon annual inspections, regular replacement of anode rods, or water chemistry.
5. Complete copies of all warranties and service policies, including all exclusions and conditions, will be presented to the owner as part of the submittal package.

B. Storage Tanks:

1. Linings for Storage tanks shall have a 15-year warranty covering manufacturing or material defects, leaks, and/or the production of rusty water.

1.3 QUALITY ASSURANCE

A. The water heater will operate at specified thermal efficiency when tested by an independent laboratory to ANSI Z21.10.3. The water heater shall comply with the thermal efficiency, standby loss, and all other requirements of the latest version of ASHRAE 90.1 and all state and local energy codes.

B. The water heater will be constructed and stamped in accordance with Section IV, Part HLW of the ASME code. The storage section of the water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure. The heating section of the water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure.

C. All water heaters used in food service applications shall be NSF approved.

D. Electric water heaters shall be U.L. listed.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATER

A. Manufacturers:

1. Design Basis: As scheduled on drawings
2. Other acceptable manufacturers:
   a. PVI
   b. State
   c. Rheem
   d. Rudd
   e. Bradford White
   f. A.O. Smith

B. Construction:

1. The storage section of the water heater shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.

2. All tank connections/ fittings shall be nonferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a manway sized access to the tank interior.

3. The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

4. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures

(amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

5. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

6. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.

7. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.

8. Lined or plated storage tanks will not be acceptable.

9. Water heaters that require anodes will not be acceptable.

10. Heating elements will be rated at 9 kW and 40 watts per square inch heat density

11. Heating elements will be sheathed in Incoloy. Each element will individually mount to the tank by means of a four-bolt bronze flange over stainless steel studs with an o-ring seal. A fused magnetic contactor will be supplied for each power circuit. Maximum current per circuit will be 50 amps on three-phase units.

12. Water heater will meet the requirements of ASHRAE 90.1– 2010.

13. Water Heater Trim

    a. As a minimum, the heater will be equipped with the following:
        1) electronic low water cutoff
        2) an immersion operating thermostat
        3) immersion temperature limiting device
        4) an ASME rated temperature and pressure relief valve
        5) and options as selected on form PV 8130

    b. Operating and safety controls shall meet the requirements of UL

    c. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.

    d. A protocol gateway for BacNet MSTP/IP will be provided

2.2 STORAGE TANKS

A. Domestic Hot Water Storage Tanks:

1. Manufacturers:
    a. Design Basis: PVI
    b. Other Acceptable Manufacturers:
        1) Rheem
        2) Rudd
        3) State

4) Cemline
5) Lochinvar
6) A.O. Smith

2. Type: Vertical
3. Construction:
   a. All tank connections/ fittings shall be nonferrous. Tank design will include a manway sized access to the tank interior.
   b. The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."
   c. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
   d. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
   e. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable
   f. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
   g. Lined or plated storage tanks will not be acceptable.
   h. Storage tank will not require anodes of any type and none will be used.
   i. Insulation: Fiber glass per ASHRAE 90.1
   j. Jacket: Steel
   k. Finish: Baked enamel
   l. Working Pressure: 150 psig
   m. Working Temperature: 180º
4. Accessories:
   a. Tank drain.
   b. Thermometer with range from 30ºF to 200ºF.
   c. Temperature pressure relief valve.
5. Certification: ASME HLW stamped and National Board Registered
6. Warranty: 25 year coverage (15 years full, 10 years prorated)

B. Expansion Tanks:

1. Manufacturers:
   a. Design Basis: Amtrol, Inc.
   b. Other Acceptable Manufacturers:
      1) Taco
      2) GFC Corp
      3) J.J. Finnigan
2. Type: Diaphragm.
3. Design Temperature: 180º.
4. Design Pressure: 150 psig.

5. Precharge Pressure: shall match cold system static pressure at location of heater.
6. Liner: Rigid polypropylene.

2.3 PUMPS

A. General:

1. Statically and dynamically balance rotating parts.
2. Construction shall permit complete servicing without breaking piping or motor connection.
3. Pumps operate at 1750 rpm unless scheduled otherwise.
4. Pump connections shall be flanged.
5. For duplex sump pumps/sewage ejectors provide a remote mounted alternating panel.

B. In-Line Circulating Pumps:

1. Manufacturers:
   a. Design Basis: Bell & Gossett.
   b. Other Acceptable Manufacturers:
      1) Armstrong
      2) Taco
      3) Grundfos
2. Model Series: ecocirc XL B
3. Pump shall be Lead-Free Bronze Body Construction.
4. Description:
   a. Type: In-line circulating pumps.
   b. Casing: Lead-Free Bronze for 125 psi working pressure.
   c. Rotor: Permanent Magnet.
   d. Shaft: AISI 420 Stainless Steel.
   e. Bearings: Carbon Sleeve.
   f. Gasket/O-Ring: EPDM
   g. All Other Wetted Parts: AISI 304 Stainless Steel
   h. Motor Type: Electronically Commutated Motor / Permanent Magnets
   i. Motor Insulation Class: F
5. Maximum Working Pressure: 175 PSI
6. Maximum Working Temperature: 230 F
7. The pump shall have the following control modes built in:
   a. Constant speed
   b. Constant Pressure
   c. Proportional Pressure
   d. Night Mode
   e. Set Point Temperature
   f. Differential Temperature
8. Pump shall be furnished with an onboard user interface
9. Readings and settings on the pump:
   a. Control and display panel
   b. Operating status
   c. Warning and alarm
   d. Errors and working log history
   e. Dry running detection
10. Input/Output
    a. 2x analog inputs (0-10v / 4-20mA)
    b. 1x external temperature sensor input
    c. 1x start/stop input
    d. 1x status output

e. Pump shall have the ability to communicate with the BMS system.

C. Oil-Minder Sump Pumps (Elevator Pits):

1. Manufacturers:
   a. Design Basis: Stancor
   b. Other acceptable manufacturers:
      1) Weil
2. Provide pump and control systems capable of pumping water while containing oil. The system shall function automatically and shall provide for an alarm and separate LED lights in the event of:
   a. The presence of oil in the sump
   b. High liquid in the sump, or
   c. High amps or a locked rotor condition.
3. LED lights shall be provided for:
   a. Power
   b. Pump run function.
4. Pump:
   a. The pump shall be a submersible type, capable of pumping up to 37' TDH and 74 GPM.
   b. The pump shall be approved to UL 778 standards and shall include thermal and overload protection.
   c. The motor shall be rated ½ H.P., 1 phase, 115V and capable of operating continuously or intermittently.
   d. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment.
5. Control:
   a. The main control shall be approved to UL 508 standards and housed in a gasketed Nema 4X enclosure with a see-through window for observation of operating functions.
   b. The control shall be equipped with an 8-pin twist lock receptacle, dual solid state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact.
   c. A Nema 4X junction box with 8-pin twist-lock electrical receptacle and 25' (additional lengths available in 25' increments) of mating 8 conductor cable shall be provided.
   d. All cables between the pump and junction box shall be 16' long and the cable and plug from the control unit shall be 8' long.
   e. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory.
   f. The system shall allow for the main control to be located outside of the elevator hoistway to be monitored for all functions without having to enter the elevator shaft.

D. Sump Basins:

1. Acceptable Manufacturers:
   a. AK Industries.
   b. Topp Industries.
   c. Fiberbasin Incorporated.
2. Material: Fiberglass reinforced polyester.
3. Minimum Wall Thickness:
   a. At Flange: ½"
   b. At Hubs: 3/8"
   c. Other Areas: 3/16"
   d. Top flange to be extended for support to suspend unit from structural slab.
4. Connections: To accommodate piping shown on drawings.
5. Cover Attachment: Tapped bronze inserts in flange for bolt down cover.
6. Size: As shown on drawings, or, if not shown, of size determined by pump manufacturer.

7. Basin Cover:
   a. Material: Steel.
   b. Provision for Lifting: Ring or handle.
   c. Cut-Outs: For removal of cover without disturbing piping or wiring.

2.4 PIPE EXPANSION COMPENSATORS

A. Any breaks or damage to the piping system or to the Work of other Sections within the period of the guarantee due to improper provision for expansion and contraction must be replaced at this Contractor's expense.

B. This Contractor is to provide for expansion of pipes by providing expansion compensators and/or expansion loops and shall provide anchors at pump discharge and suction line. All expansion loops shall be pre-stressed.

C. Make adequate provisions for proper expansion and contraction of piping. At connections of branches to water mains, risers and at connections to heaters, coolers and other equipment, provide sufficient number of elbow swings to allow for proper expansion and contraction of piping. Provide adequate elbow swings, expansion compensators, expansion loops or approved type extension joints, wherever noted, indicated, or required to allow for proper expansion and contraction of mains and risers.

D. This Contractor shall provide, where necessary to absorb expansion and contraction in hot water recirculation, pipe lines (except at building expansion joints) 3 inches and smaller and for system pressure less than 50 psi, Flexonics Model HP expansion compensators having two-ply phosphor bronze elbows and brass shrouds and end fittings, as manufactured by U.O.P. Flexonics Division, Bartlett, Illinois. All internal parts shall be of non-ferrous metals. Service pressure shall be external to the bellows. Compensators shall have integral guides extending the full length of the bellows travel. Compensators shall have external positive anti-torque devices to prevent twist.

E. This Contractor shall provide as shown on the plans and/or where necessary to absorb expansion and contraction in hot, hot water recirculation and larger and for system pressures exceeding 50 psi, Flexonics controlled-flexing expansion joints as manufactured by U.O.P. Flexonics Division, Bartlett, Illinois, or approved equal, with plate steel flanges having ANSI drilling, pipe nipple ends beveled for welding, by hydraulically formed from a stainless steel reinforcing neck ring and control rings shall be of a design to limit movement of each corrugation, as well as to carry hoop stresses caused by internal pressures. Where required, the bellows shall be annealed and/or stress relieved. Before assembly, the corrugated bellows must be pickled to remove all scale formed by annealing and passivated to provide that maximum corrosion resistance.

F. All lines in which expansion joints are installed must be securely anchored and guided in accordance with Manufacturer's recommendations.

G. Provide expansion loops/joints in all hot water and hot water circulating piping which exceeds 145 feet developed length, horizontally or vertically without offsets, and as indicated on the drawings.

2.5 ESCUTCHEONS

A. This Contractor shall provide escutcheons on all exposed pipe wherever they pass through floors, ceilings, walls or partitions.

B. Escutcheons for pipes passing through outside walls shall be Ritter Pattern and Casting Co., No. 1, solid, cast brass, flat type secured to pipe with set screws.

C. Escutcheons for pipes passing through floors shall be Ritter Pattern and Casting Co., No. 36A, split hinged, cast brass chromium plated type.

D. Escutcheons for pipes in unfinished areas shall be cast iron, secured with set screws.

2.6 TRAPS

A. Each fixture and piece of equipment requiring connection to the drainage system shall be separately trapped by means of a water seal trap placed as close to the fixture as possible.

B. All running traps on drains, etc., shall have inlet handhold cleanouts and brass plug cleanouts in bottom. Cast iron trap in ground shall have bottom plug omitted. All exposed P traps shall have bottom cleanouts and shall be chromium plated brass.

2.7 THERMOSTATIC MIXING VALVE

A. For Gang lavatories with single mixing valve: Primary/Master Mixing Valve: Leonard Model TM-186-1520B-LF-CP-BWE-EXP-TOP. Valve assembly shall be listed to ASSE 1017 and 3rd party approved as lead free. Valve shall be rated to 125 psig, 1¼" inlets and 1½" outlet, 1 GPM minimum flow and 80 GPM flow capacity at 15 psi system pressure drop. Valve shall include a dial thermometer and ball valve on the outlet, locking temperature regulator, adjustable limit stops set for 120°F (49°C), and integral hot and cold supply check stops. Valve shall be factory pre-assembled and tested, chrome plated finish. Bi-metal thermostat shall be warrantied for a minimum of 10 years. Provide a baked white enamel, surface mounted cabinet including 16 gauge body, 12 gauge door, hinged left hand door with cylinder lock where indicated on drawings.

B. For individual lavatory sinks: Temperature Limiting Devices: Leonard Model 170-LF (3/8"). Valve shall be listed to ASSE 1070 and 3rd party approved as lead free. Valve shall be rated to 125 psig, 3/8" inlets/outlet, 0.25 GPM minimum flow and a maximum of 2.7 GPM flow capacity at 15 psi system pressure drop. Valve to include locking temperature regulator and integral hot and cold supply checks. Valve options maybe include a dial thermometer, ball valve on the outlet, chrome plated (-CP) finish. Bi-metal thermostat shall be warrantied for a minimum of 10 years.

C. For individual hand sinks: Temperature Limiting Devices: Leonard Model Model 270-LF (1/2"). Valve shall be listed to ASSE 1070 and 3rd party approved as lead free. Valve shall be rated to 125 psig, 1/2" inlets/outlet, 0.25 GPM minimum flow and a maximum of 7.5 GPM flow capacity at 15 psi system pressure drop. Valve to include locking temperature regulator and integral hot and cold supply checks. Valve options maybe include a dial thermometer, ball valve on the outlet, chrome plated (-CP) finish. Bi-metal thermostat shall be warrantied for a minimum of 10 years.

D. Temperature Limiting Devices: Leonard Model 170-LF (3/8"), Model 270-LF (1/2") or Model 370-LF (3/4"). Valve shall be listed to ASSE 1070 and 3rd party approved as lead free. Valve shall be rated to 125 psig, 3/8" inlets/outlet (170-LF), 1/2" inlets/outlet (270-LF), 3/4" inlets/outlet (370-LF), 0.25 GPM minimum flow (170-LF and 270-LF) or 0.5 GPM minimum flow (370-LF) and a maximum of 2.7 GPM flow capacity at 15 psi system pressure drop (170-LF) or 7.5 GPM (270-LF and 370-LF). Valve to include locking temperature regulator and integral hot and cold supply checks. Valve options maybe include a dial thermometer, ball valve on the outlet, chrome plated (-CP) finish. Bi-metal thermostat shall be warrantied for a minimum of 10 years.

E. Provide a ASSE 1070 thermostatic mixing valve at each public lavatory whether indicated or not.

2.8 UNIONS

A. Where required: On inlet and outlet of all apparatus and equipment having connections 2" and smaller. Where valves are adjacent to equipment unions shall be on downstream side of valves.

B. Type:

1. Steel piping: Malleable iron, WOG female pattern, brass seat, ground joint, 300 lb.
2. Copper tubing: Ground joint, 150 lb. WOG pattern.
3. For piping over 2" flanged joints to be used.

C. Gaskets shall be 1/16" thick similar to Garlock or Cranite factory cut, one piece.

2.9 HOSE BIBBS

A. Hose bibbs shall be Chicago Faucets #952, MIFAB #HY-9241, or approved equal, with vacuum breaker and loose key except as specified herein. Combination hot and cold hose bibbs shall be Chicago #305-VBC.P., MIFAB #HY-8500, or approved equal; modify for piped mounting less loose flange.

2.10 WALL HYDRANTS

A. Provide 3/4" non-freeze wall hydrants where indicated on Drawings. Wall hydrants shall be Zurn A-1315, MIFAB MHY-15 or approved equal, all bronze with bronze working parts throughout, renewable nylon seat, nickel bronze face.

2.11 THERMOMETERS

A. Thermometers shall be the adjustable angle, red reading mercury type with 7" black baked enamel case, black on white scale, range from 30˚F. to 240˚F., and separable brass socket. Thermometers shall be so installed and adjusted that they are easily readable from a normal standing position on the floor, U.S. Gauge "Multi-angle".

2.12 PRESSURE GAUGES

A. Pressure gauge shall have 3-1/2" diameter black enamel cast aluminum case threaded brass ring with heavy glass, phosphor bronze bushed rotary precision movement and dial range of 0 to 200 psi for water service; Trerice Co. No. 500X or approved equal, with brass tee handle cock.

2.13 FIXED AIR GAPS

A. Provide where indicated on the Drawings or required by Code a fixed air gap to prevent contamination due to back flow in the stationary drain line. Air gap shall be Zurn No. Z-1025 or MIFAB MI- CAG to suit piping installation. Finish shall match piping connection.

2.14 HOT WATER MIXING VALVE STATION

A. Primary/Master Mixing Valve: Leonard Model TM-186-20200B-LF-CP-BWE-EXP-TOP. Valve assembly shall be listed to ASSE 1017 and 3rd party approved as lead free. Valve shall be rated to 125 psig, 2” inlets/outlet, 1 GPM minimum flow and 129 GPM flow capacity at 15 psi system pressure drop. Valve shall include a dial thermometer and ball valve on the outlet, locking temperature regulator, adjustable limit stops set for 120°F (49°C), and integral hot and cold supply check stops. Valve shall be factory pre-assembled and tested, chrome plated finish. Bi-metal thermostat shall be warrantied for a minimum of 10 years.

B. Where identified on the drawing, Primary/Master Mixing valve shall be Powers Model LFIS150VL. Lead free digital water temperature control and monitoring system shall feature full-color touchscreen interface which is configurable on location and does not require factory pre-programming. System shall control water temperature to +/- 2°F in accordance with ASSE 1017 and during periods of low/zero demand and feature a user-programmable high temperature alarm. Unit shall feature Feed Forward or Predictive Control which anticipates changes in system demand and adjusts valve pre-emptively to maintain mixed set point. Controller shall be password protected and feature a user-adjustable outlet temperature range of 80 - 180°F and an approach temperature of 2°F. System shall digitally monitor inlet pressure and temperature, mixed outlet temperature, mixed outlet set point, pressure and flow/BTUs, as well as return temperature without the use of an external module. System shall control an engineer specified recirculation pump based on user-set return temperature limits. Controller shall integrate with building automation systems through Bacnet and Modbus protocols and feature local and remote temperature alarms. System will also feature a user-set and controlled, high-temperature sanitization mode for use as part of user’s safe and properly designed thermal bacteria eradication protocol. In the event of a power failure or loss of cold water,

system will close the hot water supply. System should be mounted on a heavy-duty welded strut with corrosion resistance coating and factory tested as a complete unit.

C. Where identified on the drawing, Primary/Master Mixing valve shall be Powers Model LFIS075VL. Lead free digital water temperature control and monitoring system shall feature 3.5" full-color touchscreen interface which is configurable on location and does not require factory pre-programming. System shall control water temperature to +/- 2°F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand. Controller shall be password protected and feature a user-adjustable outlet temperature range of 60 – 180°F with high and low temperature alerts, and an approach temperature of 2°F. System shall digitally control and monitor mixed outlet temperature. Controller shall integrate with building automation systems (separate module not required) through BACnet and Modbus protocols and feature local and remote temperature alarms. System shall provide monitoring and visibility of mixing valve assets across multiple locations/sublocations. System shall offer the ability to remote temperature control for owner and admin levels. App shall be capable of sending system alerts via text and/or email and prioritizes alerts based on levels of safety and potential liability. System offers three user levels for security. System will feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency. System will also feature high speed actuator with override feature. In the event of a power failure, system will open full cold supply. In case of a loss of cold water, the system will close hot water supply.

D. Hot water mixing system shall be listed/approved to ASSE 1017, cUPC, NSF, CSA 24/UL873 and BTL (BACnet Testing Laboratories)

2.15 FLOW CONTROL FITTINGS

A. Provide flow control fittings as manufactured by the Dole Valve Company or approved equal. Flow control valves are to be installed in accordance with the manufacturer's recommendations and shall be provided for all sinks, lavatories and electric water coolers.

B. All Lavatories: Dole Model #FMA 3/8" male pipe inlet and 3/8" female pipe outlet for rigid hot and cold supply risers. Flow rate 0.5 gpm.

C. All sinks including equipment with sinks, mop receptors, service sinks and kitchen sinks, showers: Dole Model #FMC male pipe inlet and 1/2" female pipe outlet for hot and cold supply risers. Flow rates 4 gpm for service sinks and mop receptors 3 gpm for kitchen and casework sinks, 2.5 gpm for showers.

D. Electric Water Coolers: Dole Model #F3/4C male pipe inlet and 3/8" female pipe outlet for cold supply riser. Flow rate 0.5 gpm.

E. All exposed to view flow control fittings shall be chrome plated nickel, or nickel plated.

2.16 DRAINS

A. Drains shall have heavy cast iron, with double drainage flange and weep holes, with outlet connections as indicated and of sizes indicated on Drawings. Drains (except as noted) shall be furnished with high polished brass tops consisting of one-piece rim secured to the body and vandalproof spanner type screws, solid brass grate with reinforcing members on underside. Removable sediment basket shall be of heavy duty one-piece construction as specified hereinafter. All strainers or grates shall be secured with vandalproof spanner type screws, unless otherwise specified.

B. All drains in membrane waterproof floor shall be equipped with 6 lb. lead flashing or 20 oz. soft rolled sheet copper and secured to the flashing flange with brass bolts and cast iron clamping device. Flashings shall bond not less than 1'-0" on all sides into membrane waterproofing.

C. On roofs, furnish and set, in conjunction with the roofer, and when directed by the General Construction Contractor, approved roof drains of cast iron unless otherwise indicated.

D. Flashing of 6 lb. or 20 oz. soft rolled sheet copper 34" x 34" shall be furnished and installed at each roof drain by means of non-puncturing type flashing clamping device.

E. Set all drains in such a way that the floor finish and top of the drain will be plumb and flush with finish floor without requirements for future additional extension, modifications, etc.

F. When Dex-O-Tex and/or vinyl waterproof floor is indicated on the Architectural Drawings, all drains must be provided with required flanges.

G. Provide trap primers in all locations where a hose bib is not shown within 10' of a drain.

H. All drains, except as noted, shall be similar to or equal to Zurn, J.R. Smith, Josam, Wade or Ancon and shall be as follows:

1. Roof Drains R.D. - Similar and equal to no. Z-100-ERC or MIFAB #R 1200 BUV dura-coated cast iron body with combination flashing collar and gravel stop, cast iron dome, underdeck clamp and sump receiver and perforated extension collar to accommodate roof insulation. Drain must be applicable for each roof construction.

2. Floor Drains F.D. (Mechanical and Concealed Equipment Rooms) - Similar and equal to No. Z-505 or MIFAB #F1340-Y-14-4-F-50 Funnel cast iron body and flashing collar with cast iron tractor grate and flat bottom strainer. No. Z-414 cast iron funnel attached to grate, where indicated on the Drawings.

3. Floor drains F.D. (Finished Area, Shower, etc) - Similar and equal to No. ZN-415-B cast iron body, flashing collar, square nickel bronze top and ZN-414 funnel or MIFAB #F1100 C S5-1 F – 4 -1 funnel attached to grate where indicated on the Drawings.

4. Floor Drains F.D. (Kitchen) - Similar and equal to No. Z-525 or MIFAB #F1100 C S8-1 cast iron body, flashing collar, adjustable square nickel bronze top, flat bottom strainer.

5. Floor Sink F.D. - Similar and equal to No. ZN-1815-4 or MIFAB #FS 1720-22 cast iron porcelain enameled, with dome strainer, flashing flange with nickel bronze grate.

6. Area Drains F.D. - No. Z-550 or MIFAB #F1320 CY-14-1 cast iron, Duracoated, bottom outlet, non-puncturing flashing clamp device, extension, non-tilting grate with minimum free drainage area of 27 sq. inches. Drains in finished areas shall have polished nickel bronze top and grate.

7. Drain in Trenches F.D. - Z-615 or MIFAB #F1440-90-C-4-5 - Site outlet and modified to 12" open top drain, cast iron, with sediment bucket.

8. Floor Drains:

   a. Refer to Architectural drawings for exact locations and additional installation requirements.
   b. Install floor drains with P-traps and vent as required.
   c. Install drains on the center line of sheet lead pan and/or membrane in waterproofed areas and in floors above lowest floor.
   d. Clamp pan and/or membrane into drain flashing collar.
   e. Install strainers immediately after completion of finish floor installation.
   f. Coordinate locations with mechanical equipment.
   g. Install trap primers at all drains where a hose bib is not shown within 10' of drain.
   h. Provide extra heavy duty grates/strainers in locations subject to vehicular traffic.

2.17 TIE-RODS

A. Provide tie-rods for the site water main.

B. Tie-rods shall comply with NFPA 24, Specification and pipe manufacturer's recommendations.

C. Special consideration shall be given at the service entrance to the building. Provide auxiliary ties to the foundation wall, to equalize building and pipe settling.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER HEATER

A. Installation:

1. Install water heaters level and plumb in accordance with manufacturers' written instructions and referenced standards.
2. Make connections between water heaters and domestic water piping system with dielectric unions.
3. Install isolation valves at both cold water and hot water connections to water heater.
4. Furnish and install copper drain piping from temperature and pressure relief valve for water heater. Furnish drain full size of relief valve opening and extend as indicated.
5. Furnish and install acid neutralizer, if required by manufacturer. Pipe discharge of neutralizer to drain to nearest floor drain or approved receptacle.

B. Adjusting:

1. Provide start-up and adjustment by factory authorized personnel. A copy of the start-up report shall be provided to the owner.
2. Upon completion of water heater installation, verify satisfactory control operation under maximum demand conditions as recommended by manufacturer.
3. Adjust discharge water temperature as required. Make control adjustments required.

C. Start-up:

1. Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.

3.2 STORAGE TANKS

A. Install storage tank level and plumb in accordance with manufacturers written instructions and referenced standards.

B. The storage tank shall be completely factory packaged on a single skid, requiring only job site hookup to plumbing. The heater shall be insulated to ASHRAE 90.1-2010 requirements, jacketed with enameled steel panels, and mounted on heavy-duty channel skids. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

3.3 IN LINE CIRCULATING PUMPS

A. Install pumps to allow complete removal without dismantling connecting piping. Provide air cock and drain connection on horizontal pump casings.

B. Provide line sized gate valve and strainer on suction and line sized soft seated check valve and globe valve or plug valve on discharge.

C. Support pump and piping so that weight of pipe is not carried on pump casing. Additionally, support such that neither pump nor piping is supported by associated equipment.

D. Provide manual switch and aquastat where required.

E. Verify motor position is in accordance with manufacturer's installation instructions.

3.4 SUMP PUMPS

A. Provide union in discharge piping above floor.

B. Provide gate valve above floor.

C. Provide lift check valve close to pump discharge.

D. Install and adjust float control.

E. Test pump staging and float operation by flooding pit to simulate operation. Test shall be observed by Engineer or Owner Representative.

F. The alignment of all pumps shall be checked and each pump shall be properly aligned after the piping is completed and before the pumps are placed in service.

G. Mechanical seals and shaft sleeves shall be replaced by this Contractor without charge in the event the unusual wear of faulty operation occurs during guarantee period.

H. Where pump's components are or may come in contact, although the materials may basically be similar, use hardness differentials of at least 50 Brinell to prevent seizure and reduce wear.

I. Provide shaft packing or seals compatible with the pump design, fluid handled and in accordance with the manufacturer's recommendations.

J. Balance pump's impellers and all other moving components statically and dynamically.

K. Completely align and level pumps, motors and bases. Where pumps and motors are shipped as a unit, realign them in the field.

L. Grout equipment base plates completely to provide a rigid-non- deflecting support.

M. Install and align mechanical seals in accordance with the manufacturer's recommendation.

N. Provide water supply for cooling and lubrication of seals and/or packing where required.

O. Provide flexible connection for pumps. Provide spring hangers for piping for pump to partition or wall penetration.

P. Pump operation must be stable without pulsation, vibration or internal recirculation. Pump operating characteristic curves must meet the following requirements:

1. The pump operating point must fall on or below an impeller diameter curve which is not more than 85% of the maximum diameter impeller which can satisfactorily operate in the casing.
2. The pump operating point must fall below the point of no flow head pressure.
3. Pump operating point must be to the right of the midpoints of the peak efficiency curves. Selected efficiency shall be not more than 3% points below maximum efficiency.

4. A 10% increase in head pressure over the specified will result in not more than a 20% reduction in GPM and will not affect the stability of the pump

Q. Where initial and ultimate operating conditions are specified, these shall be achievable by changing the pump impeller with no modifications to the casing.

R. Upon completion of the installation, test all equipment under field operating conditions to demonstrate capability of the equipment to meet specification requirements.

S. Submit results of factory tests with the equipment shop drawings. Include result of factory and field tests in the Instruction Manual.

T. Perform field tests to demonstrate the ability of the pumping equipment to meet contract requirements. Compile and certify the following data:

1. Water flow, GPM, at rated head.
2. Shutoff head.
3. Operating kilowatts for measured voltage, amperes, power factor.

3.5 DRAINS

A. Contractor shall protect drains immediately upon installation. Drain grates shall be covered throughout construction to prevent construction debris from entering the drainage system.

B. Contractor shall test all drains just prior to turnover to confirm all drains, traps and pipes are clear and draining properly.

C. Drains, traps and pipes that are found to be clogged upon testing shall be cleaned and/or replaced, water jetted and scoped by a camera immediately, at no additional cost to the owner.

D. The contractor shall be responsible for a set period of time after project completion to clean drains, traps and pipes that do not appear clogged upon testing.

END OF SECTION

SECTION 22 30 01

COPPER SILVER IONIZATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes commercial copper silver ionization equipment.
   1. Provide complete commercial-type copper silver ionization treatment system for Legionella control within the building's water system. Designed for both continuous and proportional automatic operation. The system shall include a full assembly with flow cell(s), controller(s), flow meter, flow switch, remote monitoring system, copper piping, shut-off valves, drain valves, balancing valves, support stand, and all devices necessary for fully operational system.

B. The entire system (electronic control unit, flow cell(s), and interconnection wire) shall be ETL (UL-979 Water Treatment Appliances, UL-508 Industrial Control Equipment, and UL-1081 Swimming Pool Pumps, Filters, and Chlorinators), and CSA C22.2 (No. 14 Industrial Control Equipment; No. 108 Liquid Pumps, and No. 68 Motor Operated Appliances) certified.

C. The system shall be capable of true closed loop proportional control. Proportional control is defined as the ability to automatically, incrementally, and instantaneously adjust the output of the copper and silver ions proportionate to flow rates (water consumption) measured by a flow meter. The system shall maintain a constant level of required copper/silver ions and prevent over or under ionization during high and low water consumption periods.

1.2 SUBMITTALS

A. Submit manufacturer's product data for the following:

   1. Manufacturer's name
   2. Engineering Data Sheet.
   3. Product Data: Include efficacy data, operating characteristics of selected models, rated capacities, furnished specialties, accessories, and weights (shipping, installed, and operating)
   4. Shop Drawings:
   5. Wiring diagrams detailing field-installed wiring for power and controls.
   6. EPA Certificate of Compliance
   7. NSF Certificate of Compliance
   8. Installation and Operation Manual
   9. Maintenance Program: Maintenance Services specified in this Section
   10. Warranty: Special warranty specified in this Section
   11. Water Quality Report: Water Quality Test specified in this Section
   12. Submit manufacturer's product data for the following:

1.3 QUALITY ASSURANCE

A. The entire system (electronic control unit, flow cell(s), and interconnection wire) is ETL (UL-979 Water Treatment Appliances, UL-508 Industrial Control Equipment, and UL-1081 Swimming Pool Pumps, Filters, and Chlorinators), and CSA C22.2 (No. 14 Industrial Control Equipment; No. 108 Liquid Pumps, and No. 68 Motor Operated Appliances) certified.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for the intended use

C. Codes and Standards

   1. CSA Compliance in accordance with CSA C22.2 No. 14, No. 68, and No. 108

2. EPA Compliance in accordance with EPA Office of Prevention, Pesticides, and Toxic Substances
3. NSF Standard: Provide system constructed in accordance with NSF/ANSI Standard 61
4. UL Compliance listed and labeled in accordance with UL 979, UL 508, UL 1081 requirements

D. ASHRAE: Comply with ASHRAE Standard 188: Legionellosis: Risk Management for Building Water Systems

E. State Requirements: System shall comply with local state requirements

F. Listing and Labeling:

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100

G. Manufacturer/Product Selection: The Drawings indicate sizes, profiles, and dimensional requirements of copper silver ionization systems. Copper silver ionization systems having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided deviations do not change the design concept or intended performance. The burden of proof of equality is on the proposer

1.4 WARRANTY

A. Provide standard product warranty for copper silver ionization system including:

1. 5 year warranty on all non-consumable components that fail in materials or workmanship

1.5 MAINTENANCE SERVICE

A. Agreement to Maintain: Prior to Substantial Completion, submit 4 copies of Manufacturer's "Agreement for Continued Service and Maintenance" for copper silver ionization system, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Term of agreement shall be for 1 year with option for one-year renewal. Services shall include:

1. Monthly copper/silver level testing
2. Quarterly legionella testing (e.g. test legionella levels at most remote sink)
3. Maintenance of copper silver ionization system to ensure proper operation

1.6 SPARE PARTS

A. Provide owner with one spare copper silver ionization flow cell per installed flow cell.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATER

A. Manufacturers: LiquiTech

2.2 GENERAL DESCRIPTION

A. Factory-assembled, commercial copper silver ionization systems having capacities and for electrical characteristics indicated Product Data Submittal

2.3 COPPER SILVER IONIZATION SYSTEM

A. General: Single or multiple flow cells with the capabilities to ionize the total capacity of the required system as scheduled on the drawings

B. Flow Cell

1. Flow cell shall have a minimum working pressure of 150 PSI at 150°F.
2. Flow cell shall include consumables with the composition set by the manufacturer based on the water quality

C. Flow Cell Fittings

1. Flow cell fittings shall include two (2) CPVC threaded adaptors shipped loose, sized to the corresponding flow cell, and shall be installed by the installer

D. Flow Meter

1. Flow meter shall be manufactured from aluminum
2. Flow meter shall be ultrasonic, non-invasive, transit time flow meter
3. Flow meter shall be able to measure water consumption and provide digital read out via the digital display
4. Flow meter shall be shipped loose and shall be installed by the installer

E. Controller

1. Controller shall be high speed switching power supply up to 10 amps at 100 V DC, closed loop proportional controller, metal powder coated cabinet with 3/16 inch tempered glass inset on door, NEMA 12, operating temperature of 32°F to 131°F. 120/240 V, 60 Hz, single phase.
2. Controller shall aggregate monitoring points via the output from the manufacturer interface that communicates to both a remote telemetry and management system (REMS) platform (for remote monitoring) and visually on the local control panel. Controller shall monitor at a minimum the following system parameters:
   a. System Amps
   b. System Volts
   c. System Water Usage
   d. System GPM
3. Controller shall be capable of true closed loop proportional control. Proportional control is defined as the ability to automatically, incrementally, and instantaneously adjust the output of the copper and silver ions proportionate to flow rates (water consumption) measured by a flow meter. The system shall maintain a constant level of required copper/silver ions and prevent over or under ionization during high and low water consumption periods.
4. Controller shall be configured, controlled, and monitored from either the local control panel, or remotely (Building Management System) via 4-20 mA inputs and outputs
5. Controller shall include dry contacts for alarm conditions to connect to BAS

F. Remote Telemetry and Management System (REMS)

1. REMS shall allow for 24/7 monitoring of system: inputs and outputs, alarm conditions, control parameters, and copper/silver output and is communicated directly with Manufacturer's remote cloud based interface

2.4 ACCESSORIES

A. Threaded rods to provide additional support for each flow cell.

2.5 WATER TESTING SETS

A. Provide complete water testing set for each flow cell including but not limited to:

1. Thermometer and standard operating procedure for proper water testing and verification/validation of the system (Third party testing/verification/validation services can be sourced through the manufacturer)

PART 3 - EXECUTION

3.1 WATER QUALITY TEST

A. Prior to purchase/ordering of copper silver ionization system, contractor, at their own expense, shall collect water sample and send to manufacturer for final selection. Copy of water quality test shall be provided with official submittal to engineer

B. When submitting water quality test, also utilize manufacturer specific “engineering data sheet” with all required information filled out

3.2 INSPECTION

A. Examine areas and conditions under which copper silver ionization system is to be installed, and substrate which will support the copper silver ionization system. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to owner, design engineer, and equipment supplier

3.3 CONNECTIONS

A. Water Distribution Piping: The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to maintain services clearances per manufacturer’s recommendations
2. Connect copper water piping to units with shutoff valves, balancing valves, and unions. Additionally, provide a full-size valved bypass with balancing vales around unit
    a. Where copper silver system piping connections are dissimilar metals, install dielectric unions for joints 2” and smaller and install dielectric flanges for joints 2-1/2” and larger.
3. Install drains as indirect wastes to spill into open drains or over floor drains

B. Grounding: Connect unit components to ground in accordance with the National Electrical Code

3.4 INSTALLATION

A. Install copper silver ionization system in accordance with manufacturer’s installation instructions, and with State and local code requirements.

B. Layout: Flow cells shall be installed downstream of any softeners, if applicable. There shall be isolation valves and bypass so that the flow cell can be completely isolated from the water system during maintenance. These valves shall be separate from any balancing valves installed on the flow cell. There shall be a shut off valve for the bypass line.

C. Location: Flow cell shall not be located near electrical boxed or outlets and in a location where it is easily accessible for maintenance by a technician standing on the floor. It should be positioned no more than 54” above the floor. Controller shall be mounted to ensure there is adequate space to open the controller door and service the controller.

D. Design: Locate on the domestic hot water return system, limiting the flow rate through the flow cell to a maximum of 25 gpm if required. System shall be installed with a bypass that allow the domestic hot water return to operate during times of maintenance.

E. Design: Shut off, drain, and vent valves shall be installed before and after the flow cell for maintenance by a technician

F. Orientation: Flow cell shall be mounted vertically and have adequate clearance for maintenance by a technician.

G. Alignment: Flow cell shall be aligned with the female couplers within 0.125 inches in both the axial and lateral directions.

H. Support: Pipes leading into and out of the flow cell shall be rigidly braced and supported to prevent vertical, horizontal, and lateral movement during maintenance. Flow meter shall be mounted and braced so that it will not move.

I. Support: Threaded rods shall be installed through flange bolt holes connecting top and bottom flanges to prevent both axial spread and lateral movement.

J. Electrical: There shall be a dedicated 110/220 volt power source with dedicated 20 amp supply available for each controller.

K. Internet: There shall be access to a LAN port to allow the system to sync with REMS for remote capabilities.

3.5 FIELD QUALITY CONTROL

A. Flush and clean copper silver ionization system upon completion of installation, in accordance with manufacturer's startup instructions

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, stat units to confirm proper unit operation.

D. Sample copper silver ionization system effluent at one week intervals after start-up, for period of 3 weeks and prepare certified test report for each required water performance characteristic

3.6 DEMONSTRATION

A. Startup Services: Provide the services of a factory-authorized service representative or manufacturer to provide start-up service and to demonstrate the operation of the equipment, accessories and controls

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment

3.7 STARTUP

A. Startup of copper silver ionization systems shall occur after hot water system is operational

B. Startup schedule shall be as follows:

1. Weeks 1 & 2:

a. Customer training.

1) General: At a time mutually agreed upon between the Owner, Contractor, and Manufacturer, the Manufacturer shall provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.
2) Content: Training shall include but not be limited to:

a) Overview of the system and/or equipment as it relates to the facility as a whole.
b) Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

c) Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

3) Certification: Manufacturer shall submit to the Contractor a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Manufacturer and the Owner's representative indicating agreement that the training has been provided.

4) Schedule: Contractor shall schedule training with Owner with at least 21 days' advance notice to the Manufacturer.

b. Perform baseline copper tests
c. Startup system in continuous control mode. Slowly increase output over several days
d. Establish a copper level – 0.20 to 0.40 ppm higher than baseline

2. Week 3 & 4

a. Allow system to level off. Fine tune if necessary
b. Owner shall sample the treated water and provide samples to a laboratory to perform copper/silver tests, ICP (inductive coupled plasma) or AA (atomic absorption) – fine tune if necessary. Laboratory testing shall be part of service agreement paid for by the owner, if service agreement is chosen.

3. Weeks 4, 5, & 6

a. Remove flow cells and inspect. Removal of flow cells and inspection shall be part of service agreement paid for by the owner, if service agreement is chosen.
b. Establish cleaning frequency (per discussion between owner and Manufacturer)

C. Perform the following before start-up final checks in the presence of an authorized factory representative:

1. Water piping systems tests completed.
2. Check for piping connections leaks.
3. Test operation of safety controls and devices.

D. Perform the following start-up procedures in the presence of an authorized factory representative:

1. Energize circuits.
2. Adjust operating controls.

E. Certification: Contractor shall submit to the Engineer a certification letter stating that the system has been installed and tested per the manufacturer's installation instructions and signed by the authorized factory representative.

3.8 CLOSEOUT PROCEDURES

A. Owner's Instructions: Provide services of manufacturer's technical representative for up to 48 hours on site time to accomplish the following:

1. On site prior to copper silver ionization system to correct discrepancies
2. Copper silver ionization startup
3. Set up and program controller supplied with copper silver ionization system
4. On site for Owner training
5. Schedule training with Owner, provide at least 14 day notice to Contractor and Engineer of training date.

3.9 MAINTENANCE

A. Service provider shall provide equipment maintenance program for copper silver ionizations equipment.

B. Maintenance program shall include, at minimum, the following timeframes of activities:

1. Weekly – Water usage and flow monitoring and flushing protocols;
2. Monthly - Exchange of copper silver ionization flow cells for preventative cleaning;
3. Monthly - Copper Silver Ion testing in plumbing piping system to ensure program validation;
4. Quarterly - Legionella testing for program validation;
5. Annually – Manufacturer staff engineer to perform annual site visit to examine copper silver ionization system, ensure consistent operation, train facility staff, and answer questions;
6. As Needed - Recalibration of each flow cells once a year;
7. As Needed – Replacement of consumable copper silver bars to maintain effectiveness and efficacy of the system;

C. Maintenance program shall include remote monitoring services provided by manufacturer to ensure equipment functionality;

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data for plumbing fixtures and accessories, in accordance with Division 1.

PART 2 - PRODUCTS

2.1 GENERAL

A. All manufacturers are listed in alphabetical order and not by preference.

B. Provide factory fabricated fixtures.

C. Provide trim, carriers, valves and accessories as required for complete installation. All carriers are floor mounted unless otherwise noted. All carriers shall be bolted down to floor structure.

D. Comply with Local, State and Governing ordinances concerning maximum water requirements of plumbing fixtures: Tank type W.C. and flush valve type W.C. = 1.1- 1.6 gal./flush; lavs =0.5 GPM; urinals = 0.05- 1.0 gal./flush and showers = 2.5 GPM. Fixture performance shall be better than code limits where specified fixture offers improved performance.

E. All fixtures used for potable water service should be compliant with NSF-61. Provide fixtures which meet or exceed standards of the Federal Reduction of Lead in Drinking Water Act, Safe Drinking Water Act and Lead Contamination Control Act, NSF Standard 61, Section 9. All components in the waterway to be lead free.

F. See Architectural Drawings for fixture requirements. Fixtures specified in this plumbing specification shall be provided only if a suitable fixture is not specified in the architectural drawings or specifications.

2.2 PLUMBING FIXTURES

A. Refer to Architectural drawings for design basis of all plumbing fixtures.

B. All fixture trimmings, including faucets, strainers, escutcheons, shower head and arm, water closet supplies, stops, waste trap, escutcheons, visible hanger or chair carrier nuts shall be made of brass and shall be polished chromium plated. All material to be specified as chromium plated and shall be thoroughly and evenly applied and guaranteed not to strip or peel. All chromium plating on plumbing fixture trim shall be in accordance with Federal Spec. WW-P-54lb for grade "R" plating. Manufacturer shall submit certification that all chrome plating on finished trim meets aforementioned Federal Specification. All plated work shall be highly buffed. Plastic, zinc or white metal will not be approved.

C. All fixtures shall be free from imperfections, true as to line, angles, curves and color, smooth, watertight, nameplate in every respect and practically noiseless in operation. Fixtures as specified are given as a typical standard and they or other approved fixtures shall be furnished, set and connected in good substantial, neat and workmanlike manner.

D. All fixtures, specified to be vitreous ware, shall be fixed vitreous china ware of the best quality, non-absorbent and burned so that the whole mass is thoroughly fused and vitrified, producing a material white in color which, when fractured, will show a homogenous mass, close grained and free from pores. The glazing and vitreous china fixtures shall be white, thoroughly fused and united to the body, without discoloration, chips, or flaws, and shall be free from

craze. Warped or otherwise imperfect fixture will not be acceptable.

E. Each supply fixture, casework fixture and equipment, shall be separately controlled by its own stops. Locate as required on wall, above floor or as directed.

F. All faucets shall have metal handles.

G. All trim shall be permanently stamped with manufacturer's identification and visible after installation.

H. All fixtures, faucets, flush valves, etc., are to be ADA compliant, unless specifically noted otherwise.

2.3 WATER CLOSETS

A. Design Basis: As scheduled

B. Flush Valve: As scheduled

C. Combination water closet carriers and drainage fittings shall be Zurn Z-1203 and 1204 Series, MIFAB MC -10 L /R or MC -13 R/L, or approved equal with feet bolted to construction.

2.4 WATER CLOSET SEATS

A. General Construction: Unless otherwise specified seats shall be heavy duty solid plastic, have molded-in bumpers, concealed self-sustaining check hinge with stainless steel posts and pintles. Seat shall have an antimicrobial compound as an integral part of the plastic and shall match shape of bowl (elongated or regular).

2.5 LAVATORIES

A. Design Basis: As scheduled

B. Faucet: As scheduled

C. Unless otherwise specified, all lavatories are white.

D. Provide offset P traps on all ADA lavatory installations similar to American Standard 7723.018 grid strainer, polished chrome finish.

E. McGuire Mfg. TPC20FR (Pair) 1/4" offset threaded tailpieces.

F. McGuire Mfg. LF165LK (Pair) 3/8" SPS wall supplies with loose key stops with McGuire Manuf. 127038 cast brass set screw escutcheons.

G. McGuire Mfg. 8902C, 1-1/4" x 1-1/2" chrome plated cast brass "P" trap with cleanout plug.

H. McGuire Mfg. 2127C, 1-1/2" SPS chrome plated brass trap nipple and cast brass set screw escutcheon.

I. Supported on Zurn ZX-1231 or MIFAB MC – 41 (250 - lbs - load) concealed chair carrier with concealed arms and block feet bolted into construction.

J. All exposed piping serving plumbing fixtures that may be used for ADA purposes shall have traps and supplies insulated per ADA requirements.

2.6 MOP SINK BASIN

A. Design Basis: As scheduled

B. Faucet: As scheduled

C. Drain: Stainless steel, flat strainer, 3" IPS.

D. All mop sink faucets shall have a vacuum breaker and integral check valves.

E. Faucet shall be chrome plated with pail hook.

2.7 SHOWERS

A. Design Basis: As scheduled

B. Features: Single handle, automatic pressure and temperature balancing, and volume control, forged brass body with ceramic valving, adjustable temperature stop and polished chrome handle.

C. Heads and Arm: Polished chrome plated brass.

D. Shower valves shall turn off from hot to cold.

2.8 STAINLESS STEEL SINKS

A. Design Basis: As scheduled

B. Faucet: As scheduled

C. Mounting: Countertop, self-rimming.

D. Trap: 1½" adjustable, cast brass.

E. Stops: Loose key, ½" FPT, flexible supply, flange.

F. Provide chrome plated brass tailpiece and grid strainer.

2.9 ELECTRIC WATER COOLERS

A. Design Basis: As Scheduled

B. Industry Standards: Provide water coolers with UL and ARI labels, and which meet or exceed standards of the Safe Drinking Water Act and Lead Contamination Control Act, NSF Standard 61, Section 9. All components in the waterway to be lead free.

C. Accessories:

1. Automatic pressure regulator.
2. Stop and supply.
3. Cast brass P-trap.
4. Front push button activation.
5. Removable grid strainer.
6. Provide bottle filler when indicated.

D. Required mounting frame.

E. Evaporator and Chiller: All copper construction.

F. Finish: Heavy gauge stainless steel with No. 4 satin finish.

G. Units to meet all NSF and ADA standards.

H. Coordinate with Division 26 for power connection

2.10 BATHTUB

A. Design Basis: As scheduled

B. Faucet: As scheduled

C. Symmons "Visu-Temp" #1-2110VT tub-shower control unit or Leonard Model # 6700 – S D2L – HO3 – TS.

D. McGuire Mfg. trip lever waste and overflow.

2.11 EQUIPMENT FURNISHED UNDER OTHER SECTIONS

A. Provide all materials necessary to make final connections to equipment furnished under other Sections of these Specifications including:

1. Tail pieces
2. Stops
3. Supplies
4. P traps, standard and/or offset
5. Escutcheons

B. All fixture trimmings, including faucets, strainers, escutcheons, shower head and arm, water closet supplies, stops, waste trap, escutcheons, visible hanger or chair carrier nuts shall be made of brass and shall be polished chromium plated. All material to be specified as chromium plated and shall be thoroughly and evenly applied and guaranteed not to strip or peel. All chromium plating on plumbing fixture trim shall be in accordance with Federal Spec. WW-P-54lb for grade “R” plating. Manufacturer shall submit certification that all chrome plating on finished trim meets aforementioned Federal Specification. All plated work shall be highly buffed. Plastic, zinc or white metal will not be approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install each fixture with P trap with cleanout plug, easily removable for servicing and cleaning.

B. Provide chrome plated, rigid supplies to fixtures with stops, reducers and escutcheons. Flexible supplies will not be permitted.

C. Finish wall and floor penetrations when exposed to view in finished areas with set screw type, chrome plated brass escutcheons.

D. Set plumbing fixtures level and plumb, spaced in accordance with architectural dimensioned drawings, and securely install to be rigid. Install wall mounted lavatories, urinals and water closets with wall carriers mounted to the floor. Solidly attach floor mounted carriers for all fixture to floor using proper fasteners based on floor construction. Securely anchor flush valves behind or within walls to be rigid and not subject to movement due to push or pull action on the valve.

E. Cover fixture bolts with china bolt caps of the same color where required.

F. All wall mounted fixtures to be caulked between fixture and wall.

G. Refer to Architectural drawings and ADA standards for fixture mounting heights.

H. The Contractor shall make all plumbing connections to all equipment and fixtures requiring such connections as shown on Drawings whether the equipment and fixtures are furnished under this Section or other Divisions or Sections. Investigate the equipment furnished under other Divisions or Sections to determine if combination fittings have a means of shutoff or required the installation of check valves, backflow preventors and/or pressure reducing valves. Make final connections to such, including installations of all special traps, supplies, control valves, etc. furnished with such equipment, and furnish all material necessary that is not supplied with the equipment.

I. The Contractor shall leave valved water connections in equipment spaces and other locations where shown for the use of other trades or other Sections. On each valved outlet for equipment with submerged inlets, provide a backflow preventor after the shut-off valve. .

J. Fixture supplies and traps as specified, shall be chrome plated brass, where exposed to view. Where concealed from view in cabinets, etc., they may be rough brass. All fixture supplies shall have stops.

K. As soon as installed, all metal fixture trimming shall be thoroughly covered by this Contractor with noncorrosive grease which shall be maintained until all construction work is completed.

L. Upon completion of the Work, test flush valves and faucets for leaks or drips and adjust same for quiet operation.

M. All fixtures shall be left thoroughly clean. All plated or polished fittings, pipes and appliances shall be coated with non corrosive grease, immediately after installation, and shall be finally polished and free from all marks and foreign substances.

N. Equipment and all connections shall be in accordance with the rules relative to submerged inlets, and shall be provided with all necessary vacuum breakers and check valves, in accordance with the applicable codes.

O. Connection between any fixture with a floor outlet and the flange shall be made with an approved prepared gasket that shall be a germicide, absolutely gas and fumeproof, watertight, stain-proof, containing neither oil nor asphaltum, and which will not rot, harden or dry under any extreme of climate change, and must adhere on wet surfaces.

P. Each fixture shall be separately trapped, using the type and size of trap called for specifically in the Specifications, or the type required by the Plumbing Code. The traps shall be approved type.

Q. All fixtures requiring hot and cold water shall have the cold water faucet on the right hand side of the fixture and the hot water faucet on the left hand side of fixture.

R. The Contractor shall be responsible for protecting against injury from the building materials, acids, tools and equipment, all plumbing fixtures equipment, etc., provided under Plumbing Work Sections.

S. No slip joints will be permitted on water piping.

T. Double compartment sinks or lavatories shall be provided with faucet, trap, supplies, etc., for each compartment.

U. Funnel drains and/or floor drains shall be provided for the air conditioning, heating and refrigeration work as required.

3.2 CLEANING AND ADJUSTING

A. Cleaning:

1. Clean strainers, traps, aerators, and valves of debris, sand and dirt.
2. At completion, thoroughly clean plumbing fixtures and equipment.
3. All fixtures shall be left thoroughly clean. All plated or polished fittings, pipes and appliances shall be coated with Vaseline, immediately after installation, and shall be finally polished and free from all marks and foreign substances.

B. Adjusting:

1. After cleaning and flushing operations are accomplished, adjust flush valves, faucets, showers, bubblers for proper flow.

3.3 PROTECTION

A. Protect fixtures and related components from damage before, during, and after installation to date of Final Acceptance or Owner move-in. Provide protective coverings or other protection as required.

B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect or Engineer.

C. Remove cracked or dented units and replace with new units.

D. Contractor shall be responsible for replacing damaged fixtures or components.

3.4 SERVICES TO FIXTURES AND EQUIPMENT FURNISHED UNDER OTHER SECTIONS

A. The list of equipment for the project shall be reviewed by this Contractor, who shall include in the Contract price the costs for installing all equipment as herein specified and as claimed by the Trade Unions as Plumbing Work.

B. Refer to Architectural and Plumbing Drawings for exact locations of equipment and fixtures. Provide all materials, equipment and appliances necessary and required to complete the installation of all Hospital casework and equipment, including but not limited to the following: plumbing, roughing and final connections, valves, stops, trim, escutcheons, fittings, traps, etc. Install faucets, trim, etc., furnished with the equipment provided by others.

C. Unless otherwise detailed on Drawings, roughing of proper size and capacity for equipment indicated on Architectural, Heating and Ventilation, Plumbing or Electrical Drawings or provided under another Division or Section shall be provided and installed in such a manner and location that final connection can be made with a minimum of work and without cutting patching permanent walls, partitions, ceilings or floors. Drawings are of necessity, schematic, for special equipment as exact roughing and requirements may vary with different manufacturers.

END OF SECTION

SECTION 22 55 22

ELECTRIC HEATING CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and Division 26 Materials and Methods, Grounding, and Wires and Cables.

1.2 SUMMARY

A. Furnish and install all electric heating cable systems as specified herein and as required for freeze protection, and heating of piping, valves, fittings, drains, etc., as indicated on the Drawings. Division of work shall be as follows:

1. Plumbing and HVAC Contractors shall provide the heating cables and power distribution panels with alarm breakers, and ground fault protection.
2. The Electrical Contractor shall receive the power distribution panels and heating cables from the plumbing Contractor and install and provide power wiring to the heat trace cables.
3. The Temperature Controls Contractor shall provide and install low voltage wiring to the BMS system and assign alarm points for each panel.

1.3 REFERENCE STANDARDS

A. Each electric heating cable system and all components shall be designed, manufactured and tested in accordance with the latest applicable UL, NEMA, and ANSI Standards as well as NFPA 70 - National Electrical Code (NEC) UL508A, with City of New York Amendments.

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed and bear an MEA listing as necessary for the City of New York in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and shall include, but not be limited to:

1. Electric Heat Tracing System including cables, fittings, thermostats, installation details, circuit capacities, operational details, power distribution panel for group control, etc.

B. Submit Shop Drawings for review prior to installation. Shop Drawings shall show the overall system and each circuit, control locations, cable lengths, current required for each circuit and feed points. Provide a summary sheet of the entire system with capacity data for each line, valve, etc. See Section 26 05 02 for Shop Drawing requirements.

1.5 WARRANTY

A. Comply with the requirements of the General Conditions and Section 26 05 02.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. Design Basis: Chromalox
   a. Model: SRL – Self-Regulating Low Temperature.

2.2 ELECTRIC HEAT TRACING SYSTEM FOR WATER PIPING

A. Heat tracing system shall be designed to maintain the water temperature within the piping to at least 40ºF, but not greater that 80 ºF, with an ambient temperature of 0ºF. The piping will be insulated as specified in Division 22 in Section titled “Plumbing Insulation”.

B. Heating cables shall be UL listed electrical heating strips. The electric heat tracing may be a self regulating type of parallel circuit construction consisting of a continuous inner core of self regulating conductive material between two parallel copper bus wires suitable for operation on 120, 208 or 277 Volts, 60 hertz, single phase power. The heat tracing strips shall be capable of being cut to the desired length in the field. Operating energy shall be conserved by the self regulating feature of the heater materials, which automatically controls heat output in proportion to the heat requirement.

1. Self regulating at all points along its length.
2. 90% power reduction from 40ºF pipe temperature to 150º pipe temperature.
3. No overheating if crossed.
4. Provide outer jacket and braided copper shield for use inside roof drain leaders or on piping without a ground path.
5. UL listed and approved for use in New York State.
6. Provide tee, splice, and end seal kits as required by the manufacturer.
7. Provide digital thermostat in a NEMA 4x enclosure, with 30 amp solid state relay.

C. The heat trace cabling shall be controlled by a digital thermostat (Chromalox model DTS) specifically designed and built dedicated for heat trace systems. The thermostat shall include a 30A solid state relay, 120 volt 1 phase power, selectable soft start, programmable high & low alarms, and internal pipe stand.

PART 3 - EXECUTION

3.1 SCOPE AND REQUIREMENTS

A. Furnish and install a complete electric heating cable system, including but not limited to cable, panels, ambient air sensors, aquastats, and controls, on all water piping, fittings, drains, valves, and valve bonnets as indicated on the Drawings. The Electrical Subcontractor shall coordinate the cable installation with the Mechanical and Plumbing Subcontractors. See drawings for scope and locations.

B. All installation and materials furnished shall meet the NEC requirements and be Underwriters Laboratories listed for the application.

C. The installation and all materials, conductors, conduit, etc. utilized between the electric heating cable system, controls and distribution panels shall be as specified.

D. After the piping has been successfully pressure tested, heating cables shall be installed parallel to the pipe or by spiraling the strip to obtain the heating capacity required. All cables and components shall be installed as recommended by the manufacturer by properly trained personnel using the manufacturer specified tools and procedures and as specified herein. The heating cables shall be banded to the pipe with fiberglass tape per manufacturer recommendations. After the piping has been insulated, appropriate caution signs or markings shall be provided at frequent intervals along the pipeline in accordance with NEC requirements.

E. Heat trace cable shall be installed by a licensed electrician. Plumbing contractor shall subcontract this work to a licensed electrician if plumbing contractor is not a licensed electrician.

F. Apply the heat trace cable on the pipe after pressure testing.

1. Do not spiral wrap on pipe.
2. Make one wrap at valves.
3. Secure to pipe with methods approved by manufacturer.

G. Apply warning labels required by NEC code every 10 feet of linear heat trace visibly located outside of the insulating jacket. These labels also provide an area to write circuit information.

H. Heat trace shall be sized as follows, based on 0ºF ambient, to maintain 40ºF pipe temperature:

PIPE SIZE	1" INSULATION	2" INSULATION
Less than 2"	3 w/ft.	3 w/ft
2", 2½", 3"	5 w/ft	3 w/ft
4", 5", 6"	8 w/ft	5 w/ft
8", 10", 12"	(2 cable circuits) 8 w/ft ea.	8 w/ft

I. Provide heat tracing on all pipes installed within the intake, relief and exhaust shafts.

J. Provide heat trace on all pipes installed in enclosed perimeter shafts where separated from the exterior only by precast panels.

K. The Electrical Subcontractor shall test all electric heating cable systems for short circuits, grounds and insulation resistance. Test with 1000 VDC to a minimum resistance of 20 mega ohms.

3.2 FIELD TESTING

A. Refer to Section 26 05 03 for additional testing requirements for electric heating cable systems.

END OF SECTION

SECTION 22 90 00

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Test and balance reports
5. Record drawings
6. Permit requirements
7. Valve tag list

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for life safety systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the plumbing systems.

B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary – Plumbing

- ☐ All required submittals have been submitted and either been approved or modified in accordance with the Engineer's "make corrections noted" comments.
- ☐ All equipment has been started up and is functioning within manufacturers' recommendations without any undue noise or vibration. (Submit a list of equipment with startup dates. Provide list at a point 65% into construction schedule).
- ☐ All vibration isolation has been installed and is operating properly.
- ☐ Access doors have been installed as required for concealed equipment, water hammer arrestors, valves, controls, actuators, etc.
- ☐ All equipment has been installed with the manufacturers recommended service clearances and is fully accessible for required maintenance.
- ☐ All equipment and piping is labeled per specifications.
- ☐ All action items are complete as listed in the action items reports. Submit a list of action items with sign off by Architect or Engineer for record. Punch list to be completed prior to turn over of building.
- ☐ Contractor to test all drains to verify that they are clear and draining properly upon project completion.
- ☐ Operation and maintenance manuals submitted with table of contents and required documentation for extended warranties.
- ☐ Factory Testing documented and submitted for record.
- ☐ Record drawings submitted per specifications.
- ☐ PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 COORDINATION WITH OTHERS

A. The Division 21 through 23 contractor shall coordinate his requirements with the General Contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 21 through 23 systems.

3.3 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

DIVISION 23
HEATING, VENTILATING AND AIR CONDITIONING

SECTION 23 05 01

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. The Divisions 21, 22, 23, 24, 25, 26, 27 and 28 contractor(s) shall comply with the provisions of this section. The Divisions 21, 22, 23 and 25 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26, 27 and 28 contractor(s).

B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21, 22, 23 and 25 System Contractor performing the work, which requires the electrical power.

1. Each Divisions 21, 22, 23 and 25 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26, 27 and 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical), and Division 23 and 25 (control) before submitting any equipment for review or commencing installation.

1.3 DEFINITIONS

A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.

B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.

C. Motor Control Center: A floor mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.

D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.

E. Manual Operation: Operation by hand without the use of any other power.

F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.

G. TC: Temperature Controls = Division 22, 23 or 25 Contractor who furnishes control.

H. EC: Electrical Contractor = Divisions 26, 27or 28 Contractor.

I. FA: Fire Alarm Contractor = Division 25 or 28 Contractor who furnishes Fire Alarm System.

J. SC: Sprinkler Contractor

K. EP: Electric to Pneumatic Converter.

L. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21, 22, 23 and 25 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished By	Set In Place By	Power Wiring By	Control Wiring By
AHU Interior Marine Lights	MC	MC	EC	EC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Motor Speed Controllers: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC, EC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC, EC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC, EC or TC	MC or TC	MC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	MC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	SC	SC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC/FA
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 7)	FA	FA	EC	FA
CO Sensors	TC	TC	TC	TC
Control Air Compressor	TC	TC	TC	TC
Refrigerated Air Dryer	TC	TC	TC	TC
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA/TC (Note 7)
Smoke Control Dampers (for smoke management system) (Note 7)	MC	MC	EC	FA/TC (Note 7)

ITEM -	Furnished By	Set In Place By	Power Wiring By	Control Wiring By
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC (Note 7)

Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC. Electrical Contractor shall provide disconnects for all electrical equipment unless otherwise indicated.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor. Such devices shall be provided at low voltage unless technically impossible
3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided by the electrical contractor.
4. Electrical contractor is responsible for wiring from disconnect to starter and from starter to motor, unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
   a. Electrical Contractor shall provide all power and control wiring to fire/smoke or smoke dampers. HVAC, Controls, Electrical, and Fire Alarm Contractors shall provide parallel control wiring (with fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes, unless otherwise indicated.
   b. Fire alarm system shall override automated building control system during smoke exhaust mode.
   c. TC shall provide additional required wiring and controls when damper also serves a temperature control or zoning function.
7. FA wires to components necessary for the operation and monitoring of the Smoke Management System. TC wires to components utilized in the control and monitoring of the Automated Building Control System. This often requires dual wiring where components are controlled by both. In such case wiring and relays shall be provided to ensure FA takes precedence in control over TC.

B. Power Wiring by Divisions 21, 22, 23 and 25: The electrical power for certain equipment provided under Divisions 21, 22, 23 and 25 may not be specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21, 23 or 25 trade requiring such power.

Sufficient power for this purpose shall be furnished as “spare” dedicated circuit capacity in Division 26’s panelboards. All wiring, conduit and electrical devices downstream of the panelboards is the responsibility of the Divisions 21, 23 and 25 trade requiring the power.

1. Such equipment is hereby defined as:
   a. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing drawings.
   b. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Fire Protection work, and will be shown by that contractor’s engineered system design drawings.
      1) Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under fire alarm work.
      2) Sprinkler Contractor shall provide pre-action control panel and interconnection between nearest suitable fire alarm panel and location of pre-action valve(s).

3) Fire Alarm Contractor shall provide interconnection between fire command center alarm panel and/or remote communication fire alarm panel.

c. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.

d. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in HVAC scope and will be shown by that contractor's control submittal drawings.

e. Motorized dampers and VAV boxes. Required locations and specification are shown on the mechanical drawings and HVAC specifications. HVAC contractor shall provide damper, controls and power.

1.5 GENERAL REQUIREMENTS

A. Connections:

1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

1. Provide magnetic starters for all three phase motors and equipment complete with:
   a. Control transformers.
   b. 120V holding coils.
   c. Integral hand-off-auto switch.
   d. Auxiliary contacts required for system operation plus one (1) spare.
   e. Refer to Motors, Starters and Drives, requirements for additional information.

C. Remote Switches and Pushbutton Stations:

1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. DDC Control Interface:

1. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System prior to submitting bid.

2. All power to controllers and controlled equipment shall be furnished via dedicated line voltage circuits.
3. Dedicated control circuits from electrical panelboards to DDC control panels and from electrical panelboards to dedicated DDC J-boxes (for distributed control components such as VAV boxes), and control transformer line voltage connections shall be provided by HVAC Contractor where required.
   a. Exceptions: Where power wiring has been shown on Electrical Drawings.
4. Low voltage wiring from J-boxes to distributed control components, all low voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23 or 25.
5. Any additional power requirements shall be the responsibility of the Division 23 or Contractor requiring same, and provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste/sanitary, cooling coil drain piping, and roof drain mains and leaders.
2. Plumbing vent piping.
3. Supply, return and exhaust ductwork.
4. Electrical conduit greater than 3" diameter.
5. Hydronic branch and mains (greater than 2", but less than 12").
6. Domestic water mains piping.
7. Fire sprinkler mains and leaders.
8. Hydronic branch piping (2" and less).
9. Domestic water branches.
10. Electrical conduit branch feeders.
11. Fire sprinkler branch piping and sprinkler runouts.

B. Light fixtures have precedence in a zone, extending from the face of the ceiling to an elevation 2" above the height of the light fixtures.

C. Examine the contract documents of all trades (e.g. all Divisions 21, 22, 23, 25, 26 and 28 the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).

D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.

E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.

F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise unaccessible locations.

1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.
2. All system components requiring access shall be grouped together to reduce the quantity of access doors required.

G. See "Basic Mechanical Materials and Methods" for additional access door requirements if section has been included in this specification.

PART 2 – PRODUCTS

2.1 MOTOR HORSEPOWER

A. In general, all motors ½ HP and above shall be three phase, all motors below ½ HP shall be single phase.

B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.

C. Work under Divisions 21, 22 and 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26, 27 and 28, before ordering the equipment.

1. If motor horsepowers are changed under the work of Divisions 21, 22 or 23 without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21, 22 or 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (Not Used)

END OF SECTION

SECTION 23 05 02

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1 - General Requirements.

B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is more stringent.

C. Provisions of this section shall also apply to all sections of Divisions 21, 22 and 23.

1.2 DEFINITIONS

A. The definitions of Division 1 and the General Conditions of this specification also apply to Divisions 21, 22, 23 and 25 Contract.

B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor’s bid or contractor’s negotiations with the Owner. Divisions 21, 22, 23 and 25 drawings and specifications prepared by the Engineer are not construction documents.

C. “Construction Documents”, “construction drawings”, and similar terms for Divisions 21, 22, 23 and 25 Work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s contract documents. These specifications detail the contractor’s responsibility for “Engineering by Contractor” and for preparation of construction documents.

D. “(E)” indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.

E. “(R)” indicates existing equipment to be relocated as part of this work.

F. "Furnish" means to "supply" and usually refers to an item of equipment.

G. "Install" means to "set in place, connect and place in full operational order".

H. "Provide" means to "furnish and install".

I. “Equal” or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.

J. "Work by other(s) divisions"; "re:_____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor’s sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Architect/Engineer before submitting bid.

K. By inference, any reference to a “contractor” or “sub-contractor” means the entity, which has contracted with the Owner for the work of the Contract Documents.

L. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

M. "Piping" includes, in addition to pipe, all fittings, valves, hangers and other accessories related to such piping.

N. "Concealed" means hidden from sight as in chases, furred spaces shafts, hung ceilings, or embedded in construction.

O. "Exposed" means, "not concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "concealed" unless otherwise specifically noted.

P. "Governmental" means all municipal, state and federal governmental agencies.

Q. Where any device or part of equipment is herein referred to in the singular number (such as "the pump"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.

R. "HVAC" means Heating, Ventilating and Air Conditioning.

S. "Plumbing Contractor" means the Contractor doing Plumbing work.

T. "Fire Protection Contractor" means the Contractor doing Fire Protection work.

1.3 COORDINATION

A. Contract Documents:

1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within the Division's work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.
2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Architect/Engineer during the progress of the work. Make reasonable modifications in the layout as needed to prevent conflict with work of other trades.
3. Discrepancies:
    a. Examine Drawings and Specifications of all Divisions of the work.
    b. Report any discrepancies to the Architect/Engineer and obtain written instructions before proceeding.
    c. Should there be a conflict within or between the Specifications or Drawings, the most stringent or higher quality requirements shall apply.
    d. Items called for in either specifications or drawings shall be required as if called for in both.
4. Constructability:
    a. Examine Drawings and Specifications of all Divisions of the work.
    b. Report any issues to the Architect/Engineer which may prevent installation of Divisions 21, 22, 23 and 25 work in accordance with the Contract Documents and the original construction contract.
    c. Report all issues within 30 days after contract.

B. Be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service. This coordination shall include, but not be limited to, the following:

1. Fire Protection Contractor shall provide shop drawings to HVAC and Plumbing Contractors.
2. Automatic Temperature Controls, Building Management and Test-Adjust-Balance Contractors shall be provided with equipment product data and shop drawings as appropriate from all other contractors, and shall furnish the same information about control devices (such as valves, test wells, etc.) to the appropriate Contractors.

C. Coordination Drawings:

1. Submit coordination drawings for all HVAC, Plumbing, Fire Protection and Electrical work. The drawings shall be fully coordinated and signed off by all affected trades prior to submission. The coordination drawings shall include the following at a minimum:
   a. All major ductwork, piping, conduit and equipment.
   b. Reflected ceiling plans with light fixtures.
   c. Current architectural floor plans.
   d. Major structural elements.
   e. Elevations of piping ductwork or equipment.
   f. Sections through critical spaces.
2. The drawings shall be at a suitable scale (3/8"=1'-0" minimum) to clearly show information.
3. Any work installed without approved coordination drawings is done at the Contractor's risk.

D. CAD Drawings:

1. Electronic Auto Cad drawings are available from M-E Engineers. The service charge for the delivery of these files is $200 per floor plan per trade. Contractor will be required to execute a file transfer agreement.

E. Existing Conditions:

1. Inspect existing conditions prior to bidding.
2. Provide proper coordination of mechanical work with existing conditions.

F. Utility Connections:

1. Coordinate the connection of mechanical and electrical systems with the Civil drawings and utility companies.
2. Comply with regulations of utility suppliers.
3. The Contract Documents indicate the available information on existing utilities and services, and on new services (if any) to be provided to the project by utility companies and agencies.
   a. Notify Architect/Engineer immediately if discrepancies are found.

4. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company. Plan work so that the duration of the interruption is kept to a minimum. This shall include premium time, shift labor and multiple crews to accelerate the work and lessen the impact on facility operations.

G. If the project is constructed under multiple bid packages each Contractor shall coordinate their work with the progress of the other contractors performing similar or unrelated work.

H. Coordinate ceiling cavity space carefully with all trades.

I. Coordinate with Electrical Work.

J. Cutting and patching as specified.

K. Chases, Inserts and Openings:

1. Provide measurements, drawings, and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.
2. Check sizes and locations of openings provided. Any cutting and patching made necessary by failure to provide measurements, drawings, and layouts at the proper time shall be done at no additional cost to the Owner.
3. Coordinate roof openings for all roof-mounted equipment. Openings on documents are diagrammatic and do not represent manufacturer specific requirements. Actual opening size, orientation and location, as well as

structural coordination, is the responsibility of the mechanical contractor. Provide transitions on ductwork to accommodate actual roof openings.

L. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

M. The work throughout shall be executed as quickly as conditions permit in the best and the most thorough manner under the direction of and to the satisfaction of the Engineers, Owners and Architects, who will jointly interpret the meaning of the Drawings and Specifications, and shall have the power to reject any work and materials which, in the judgment, are not in full accordance therewith.

N. The work called for under this contract shall be carried on simultaneously with the work of other trades in a manner such as not to delay the overall progress of the work. Furnish promptly to other trades involved at the project, all information and measurements relating to the work which they may require. Cooperate with them in order to secure the harmony necessary in the interest of the project as a whole.

O. Keep a competent superintendent in charge of the work at all times. Such superintendent shall be replaced if unsatisfactory to the Owner.

P. Upon award of contract, consult with the Architect and negotiate with subcontractors and manufactures, and within thirty (30) days submit five (5) copies of a preliminary list of major equipment, for approval, complete with name of manufacturer, dates of purchase orders, and delivery dates to the site. Also submit within thirty (30) days, five (5) copies of a preliminary schedule of installation of the various systems. The list shall be revised monthly and five (5) copies shall be submitted. The second submittal shall contain the names of manufacturers of scheduled equipment (with names, addresses, and telephone numbers of local representatives).

Q. Maintain a complete file of shop drawings at all times available to the Owner's representatives.

R. Every facility shall be provided to permit inspection of the work by the Owner's representatives during the course of construction.

S. Where items of equipment and/or materials are indicated in the Specifications as being furnished by other trades for installation, assume responsibility for the unloading of such equipment and/or materials from the delivery trucks, and for providing safe storage for same as required pending installation.

T. Where the work is to be installed in close proximity to work of other trades, or where there is evidence that the work is to interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment.

Prepare composite working drawings and sections at a suitable scale not less than 3/8" = 1'-0" clearly showing how the work is to be installed in relation to the work of other trades. If the installation is made before coordinating with other trades, make all necessary changes in the work without extra charge to the Owner.

1.4 ENGINEERING BY CONTRACTOR

A. The construction of this work requires the Contractor to perform certain design activities with regard to several of the Contract Mechanical systems or subsystems that can only be fully ascertained with regard to the prevailing site field conditions during construction activities. All such designs and related activities shall be the complete responsibility of the Contractor. Where these design activities require engineering, it is the responsibility of the Contractor to engage the service of a licensed New York State Professional Engineer experienced in the areas related to the design activities performed by the Contractor.

B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:

1. Any system not fully detailed on the drawings.
2. Fire sprinkler.
3. Geothermal field arrangement, well location and total capacity

4. Equipment supports, not fully detailed in the drawings.
5. Pipe hangers and anchors not specified in these documents, or cataloged by the manufacturer.
6. Vibration isolators and seismic restraints.
7. Duct supports, hangers and miscellaneous steel as required.
8. Temperature controls.
9. Refrigeration systems.
10. Piping expansion and contraction provisions.
11. Equipment supports, hangers.
12. Ductwork support systems.

C. Contractor's design responsibility shall include system design, any required calculations to support system design, any compliance documents or certifications by any governing body up to and including replacement of design engineer with a different engineer of record, retained and paid by the contractor, as determined by authorities or original design engineer.

D. Contactor shall complete all controlled or special inspections and file all required paperwork in a timely manner. Professional engineer retained by contractor to serve as "special inspector" shall meet all requirements for special inspector as determined by the authority having jurisdiction.

E. Where the contract documents indicate "Verify in Field" or "Contractor to Verify" or other similar terms, the contractor shall be responsible for verifying the extent of the work by performing field investigations prior to submitting their bid. All costs associated with performing the complete scope of work, as determined by the contractor's field verification, shall be included in the contractor's bid price.

1.5 REGULATORY REQUIREMENTS

A. Codes: Comply with the latest editions of the following:

1. New York State Mechanical Code.
2. New York State Plumbing Code.
3. Building Code of the State of New York.
4. ASHRAE 90.1-2013 (As allowed by C401.2 of the New York State Energy Conservation Code)
5. International Building Code.
6. International Mechanical Code.
7. International Plumbing Code.
8. National Electric Code.
9. ASME Boiler and Pressure Vessel Code.
10. Local Modifications to above Codes.

B. Applicable NFPA Standards.

C. Requirements of Local Utility Companies:

1. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

D. Other Regulations: Comply with the latest editions of the following:

1. U.S. and State Department of Labor Safety Regulations pertaining to the completed project.
2. Requirements of Fire Departments serving the project.
3. Regulations of the Health Department having jurisdiction. Including New York State D.O.H.
4. Regulations of the Fire Marshal.
5. ASHRAE Energy Conservation Standard 90A.
6. ASHRAE Ventilation Standard 62.1
7. ASHRAE 13

8. ASHRAE 135
9. Americans with Disabilities Act (ADA).
10. Clean Air Act.
11. Clean Water Act.
12. NFPA National Fire Protection Association
13. ANSI American National Standards Institute
14. ASTM American Society for Testing Materials
15. AWWA American Water Works Association
16. IBR Institute of Boiler and Radiator Manufacturers
17. NEMA National Electric Manufacturers Association
18. SMACNA Sheet Metal and Air Conditioning National Association, Inc.
19. ARI Air Conditioning and Refrigeration Institute
20. UL Underwriters' Laboratories
21. AMCA Air Moving and Conditioning Association
22. ADC Air Diffusion Council
23. AABC Associated Air Balance Council
24. Local Water Company Rules and Regulations
25. Vassar Design Standards.

E. Additional Regulations: Follow additional regulations, which appear in individual Sections of these Specifications.

F. All piping shall be domestically manufactured and shall be by the same manufacturer.

G. All equipment and materials shall complete with Vassar College Standards.

H. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. Architect/Engineer shall determine which is most stringent.

I. Contract Documents Not in Compliance:

1. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer, in writing during the Bidding Period, of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
2. Follow Drawings and Specifications where they are superior to Code requirements.

J. Contractor as Technical Expert

1. When the contractor declares himself to be an expert with regard to how a system must be constructed or what will be required to gain code official approval, it shall be assumed that the contractor was an expert at the time of bid and has included all costs associated with proclaimed "required" work in his base bid.

K. The Contractors bid shall be based on the execution of all work required to allow the contractor to self-certify the work of the project. Self-certification shall be performed if requested by the Owner. Submitting a bid for the contract work shall be considered confirmation by the contractor that he is in good standing with the department of buildings with respect to self-certification.

L. Work of contract shall be bid as described in contract document including all details, notes, plans, routing, etc. Contractor's intentional or unintentional exclusion of scope or assumptions about alternate construction methods, configurations, materials or testing shall be at the contractors risk and the engineer reserves the right to require that the work be constructed per plans. Statements such as "I did not bid it that way", or "I don't have that in my price", shall be understood to be an admission of the contractors error but will have no effect in reducing the contract requirements or increasing the cost to the Owner.

M. Permits

1. Obtain all permits required by authorities and agencies having jurisdiction for the work of this Division.
2. Post permits as required.
3. Obtain all approvals, including controlled inspections, prior to request for final payment.

N. Tap and Connection Fees:

1. Pay fees charged by Utilities for making connections, bringing service to property line, or to meter and similar services.
2. Investment fees or plant development fees, which are charges levied by Utilities to cover the cost of the utility system to be borne by this project, are not part of the work of this Division.

O. Inspections and Tests:

1. Arrange for all required inspections and tests.
2. Pay all charges.
3. Notify Architect/Engineer 48 hours before tests.
4. Submit one copy for Owners records of permits, licenses, inspection reports and test reports.

1.6 RECORD DRAWINGS

A. General Recording Procedure:

1. Maintain a blue-line set of Sprinkler, Plumbing and HVAC Contract Drawings in clean, undamaged condition, for mark-up of installations, which vary, from the Contract Drawings.
2. Record changes drawn to scale and fully dimensioned.
    a. Work concealed behind or within other work, in an inaccessible arrangement.
    b. Mains and branches of piping systems:
        1) with valves and control devices located and numbered.
        2) with concealed unions located.
        3) with items requiring maintenance located (traps, strainers, expansion compensators, tanks, etc.).
    c. Underground piping and ducts, both exterior and interior.
    d. Ductwork layouts, including locations of coils, dampers, filters, boxes and similar units.
    e. Concealed control system devices and sensors.

B. Corrected Drawings:

1. Obtain a set of contract drawings on CAD.
2. Update the CAD files to reflect as-built conditions.
3. Transmit corrected CAD files and plots as a submittal to the Architect/Engineer for Owner’s use and record.

C. Temperature Control Drawings:

1. Provide as-built Drawings of work under this contract including:
    a. Ladder wiring diagram.
    b. Pneumatic schematic diagrams.
    c. One line system diagram.
    d. Control schematic of equipment with control devices located and identified.
    e. Wiring or tubing termination diagrams.
    f. List of materials.
    g. Floor plan indicating all device locations.
    h. Control sequences.
    i. Indicate electrical power source for each point of connection to the electrical system.

2. Reproducible temperature control drawings and computer files shall be delivered to the Architect/Engineer prior to Owner's acceptance of project.

1.7 OPERATING AND MAINTENANCE DATA

A. Submission:

1. Submit typed and bound copies of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner.
2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings. Mark the back spine of each binder with system identification and volume number.

B. Required Contents:

1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on specific piece of equipment.
2. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
    a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
    b. Operating instructions for complete system including:
        1) Emergency procedures for fire and failure of major equipment.
        2) Major start, operation and shut-down procedures.
    c. Maintenance Instructions for each piece of equipment including:
        1) Equipment lists.
        2) Proper lubricants and lubricating instructions for each piece of equipment.
        3) Necessary cleaning, replacement and/or adjustment schedule.
        4) Product Data.
        5) Installation instructions.
        6) Parts lists.
        7) Complete wiring diagrams.
    d. Temperature control diagrams and O&M information as specified above (as-built).
    e. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
    f. Balancing Report.
    g. Valve schedule and associated piping schematics. See "Identification" specification sections.
    h. Copies of any extended equipment warranties, which are greater than one year.

1.8 WARRANTIES

A. The warranty period is one year after Date of Acceptance.

1. During this period, provide labor and materials as required to repair or replace defects in the mechanical system at no additional cost to the Owner. Provide certificate with O&M manual submittal which guarantees same-day service response to Owners call for all such warranty service.
2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies in O&M manuals. Such equipment shall include, but not be limited to:
   a. Temperature Control Valves five (5) years.
   b. Chiller compressors five (5) years.
3. Provide extended manufacturers warranties to cover one full year from date of acceptance if standard warranty starts any time prior to that date.
4. Provide factory trained service personnel for all warranty work on the following equipment:
   a. Building Management System
   b. VRF Systems
   c. Air Handlers
   d. Packaged Equipment
   e. Geothermal System
   f. Solar PV and Solar Thermal Systems

B. Refer to Division 1 for additional requirements.

1.9 INDEMNIFICATION

A. Pay all royalties and defend all suits or claims for infringement of any patent rights and save the Owner harm from loss on account thereof.

B. If process or article specified is an infringement of patent, promptly notify the Architect in writing, and any necessary changes shall be as provided in the Contract for changes in the work. If the Contractor performs any work specified knowing it to be an infringement of patent, he shall bear all costs arising therefrom.

C. Take out all necessary insurance, free of extra charge, and agree to indemnify and save harmless the party contracting for services against loss or expense, by reason of the liability imposed by law upon such party for damages because of bodily injuries, including death at any time resulting therefrom, accidentally sustained by any person or persons or on account of damage to property arising out of or consequence of the performance of this Contract, whether such injuries to persons or damaged property are due or claimed to be due by any negligence in the performance of the Contract, the party contracting for services, employees or agents, or any other person.

1.10 SCOPE

A. The Contractor shall:

1. Supply all labor, transportation, materials, apparatus, light, and tools necessary for the completion of the mechanical work.
2. Install, maintain, and remove all construction equipment.
3. Be responsible for safe, lawful, and proper construction execution.
4. Construct, in the best and most workmanlike manner, a complete project and everything properly incidental thereto, as shown on the Drawings, as stated in the Specifications, or reasonably implied therefrom, all in accordance with the Contract documents.

B. Work Included

The Work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all Heating, Ventilating and Air Conditioning Work, as shown on the Drawings and hereinafter specified, including, but not limited to the following.

1. All motor starters and controllers for equipment furnished by this Contractor. Packaged type units shall be furnished completely pre-wired with panels mounted on the units as specified. All other motor starters and controllers will be turned over to the Electrical Contractor for installation and wiring.
2. Provide a complete vertical-bore geothermal system, including well drilling, grouting, piping distribution, manifold, etc.
3. Pumps
4. Filters.
5. Fans.
6. Heat exchangers.
7. Electric boilers.
8. Cabinet and unit heaters, electric baseboard radiation, trench heaters, etc.
9. Packaged ground-source heat pumps units complete with compressors, controls, enthalpy wheels, electric coils where specified.
10. Condensate pumps and piping to floor drain, drain main, or janitor sink.
11. Hydronic specialties such as expansion tanks, air vents, air separators, reducing and safety valves, etc.
12. Accessories such as V-belt drives, flow measuring devices, draft gauges, machinery guards, thermostats, pressure gauges.
13. Water treatment for closed-loop hydronic systems including: ground source water system, condenser water system, solar thermal water system.
14. Inertia blocks and vibration isolation equipment.
15. Piping, fittings, and valves.
16. Sheet metal ductwork and accessories, including dampers, access doors, etc.
17. Grease exhaust system including fire-wrap, cleanouts, access doors, connections to food service equipment, etc.
18. Registers, grilles and diffusers.
19. Fire dampers, smoke dampers and fire/smoke dampers.
20. Installation of smoke detectors in ductwork.
21. Acoustical duct lining, where specified or shown on drawings.
22. Pipe, duct and equipment insulation.
23. Energy Recovery Units
24. Split systems.
25. Water-cooled VRF systems, including heat recovery units where specified.
26. Air-cooled VRF systems.
27. Constant and variable volume air terminals.
28. Temperature Control: A complete system of temperature control shall be installed in connection with the HVAC systems, including all thermostats, air piping, damper motors, etc. All control wiring for automatic temperature controls, including interlocking wiring for fans, chillers, pumps, etc. by this Contractor, unless otherwise shown on the electrical Drawings.
29. Integrated Room Automation System
30. Excavation and backfill as specified under “Special Requirements for Mechanical and Electrical Work”.
31. Painting and pipe identification for all work by this Contractor is previously specified under “Special Requirements for Mechanical and Electrical Work”.
32. Test and balancing.
33. Sleeves, pipe inserts and anchor bolts, escutcheons, prefabricated roof curbs, etc., as hereinafter specified.
34. Identification, name plates, tags and charts.
35. Cutting and rough patching.
36. Furnishing and setting of electric motors.
37. Furnishing of starters and motor control devices as specified under “Special Requirements for Mechanical and Electrical Work”.

38. Templates and anchor bolts for equipment bases.
39. Cap flashing for pipe and duct passing through roof.
40. Removal, relocation and/or demolition of existing HVAC work in conjunction with the existing buildings in order to erect the new buildings as indicated on the Contract Drawings.
41. Furnishing of access doors.
42. Energy management (building automation) system.
43. Concrete pads for all HVAC work.

1.11 SPECIAL INSPECTIONS

A. Contactors shall provide all required special inspections for all work performed. Contractor shall retain a third party Architect or Engineer, independent of the primary design team and contractor, to complete all required inspections and execute all required TR-1 documents and any additional documents that may supplement or replace these documents in the future.

B. Contractors' special inspection engineer shall be in good standing with the Department of Buildings and shall meet all requirements and qualifications established by the Department of Buildings. This shall include education, formal training, in-service training, corporate structure, certifications, professional development, etc. If, at any time, the Architect or Engineer shall fail to meet the qualification requirements of the Department of Buildings the contractor shall replace the Architect or Engineer with another qualified professional.

C. If at any time the Architect or Engineer shall fail to produce required inspections and associated documentation in a timely manner, the contractor shall replace the Architect or Engineer with another qualified professional.

D. All inspections shall be completed in strict accordance with the requirements established by the Department of Buildings. Records of inspections shall be maintained in accordance with good practice, but in no case less than 6 years from time of filing. Documentation shall be in accordance with requirements established by NYSDOB.

E. The work of the project will be phased and completed on an accelerated schedule. This will create a need for multiple inspections and inspection documentation filings. Architect and Engineers performing inspections shall fully understand the phasing of the work and be prepared to complete inspections and provide filing documents in accordance with the established schedule. The inspector shall expect that multiple inspection visits may be required to support a single inspection filing.

F. Special inspector shall have no financial interest in the construction, installation, maintenance of structures or components that they inspect.

G. Special inspector shall cooperate with any audits or inquiries initiated by NYSDOB or other authorities having jurisdiction.

H. Special inspectors shall limit the scope of their inspections to systems and installations that their education, experience, certifications, etc., qualify them to inspect.

I. Special inspectors shall report any discrepancies or deficiencies to the contractor immediately upon detection and shall follow-up with contractor to confirm that conditions have been corrected or repaired.

J. Special inspection agencies shall carry insurance in the coverage limits established by NYSDOB. At a minimum, this shall be a $500,000 professional liability policy, $1,000,000 general liability and other statutory insurance at statutory limits.

K. Special inspection agencies shall have a full time director in responsible charge that does not serve as an inspector or director for any other testing agencies.

L. Controlled/special inspections shall be provided as follows:

1.	Fire Dampers, Fire Smoke Dampers, Smoke Dampers	BC 1704.15
2.	Fire Stopping	BC 1704.25
3.	Emergency Lighting	BC 1704.13, BC 2702
4.	Emergency Power System (Generators)	BC 1704.13, BC 2702
5.	Ventilation System	BC 1704.15
6.	Smoke Control System	BC 1704.14
7.	Sprinkler Systems	BC 1704.21
8.	Standpipe Systems	BC 1704.22
9.	Fire Alarm	BC 907, BC 1704.13
10.	Refrigeration System	BC 1704.15
11.	Mechanical Demolition	BC 1704.19, BC 3306.6
12.	Heating Systems	BC 1704.23
13.	Seismic Isolation	BC 1707.8

1.12 MANDATORY GOVERNING PROVISION

A. Omissions of words or phrases, such as “the Contractor shall,” “in conformity with,” “shall be,” “as noted on the Drawings”, “according to the Drawings”, “an”, “the”, and “all”, may or may not be intentional.

B. Omitted words or phrases shall be supplied by inference.

1.13 PROTECTION OF PROPERTY AND MATERIALS

A. Provide protection against dust migration, rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus, and fixtures free from injury or damage.

B. At end of each day’s work, cover all new work likely to be damaged.

C. Do not interrupt the integrity of the building security during periods when the project is staffed or during periods where the project isn’t staffed.

1.14 OWNER FURNISHED EQUIPMENT

A. All equipment called out in the Specifications or shown on the Drawings as “Owner-Furnished Equipment” shall be installed and connected under this Contract. Provide rough-ins, and final connections for all equipment.

B. Kitchen and sterilization equipment will be furnished and set in place under other Sections of the Specifications.

C. Furnish and install all shutoff valves and traps and piping for each item of equipment. Any additional pipe and fittings required for kitchen and sterilization equipment, made necessary by roughing outlets not being located where shown on the manufacture’s approved Drawings, shall be furnished and installed by the Contractor.

D. All such work that is not concealed in the construction or in base cabinets or compartments, shall be polished nickel and chromium plated red brass pipe, with cast brass fittings, cast brass escutcheons, valves, and traps all finished with polished chromium plating over nickel plating.

E. All work in connection with such equipment shall be done under the supervision of the manufacturer and the Contractor shall be responsible for any damage to any of the equipment that may result from his work in connection therewith.

1.15 TEMPORARY FACILITIES

A. Light, Heat, Power, etc.

1. Temporary power and lighting shall be provided by the electrical contractor.
2. Temporary heat shall be provided by the HVAC Contractor.
3. The contractor shall be responsible for maintaining acceptable indoor air quality in adjacent occupied spaces.

B. Use of Permanent Building Equipment for Temporary Heating or Cooling.

1. Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. The contractor shall protect all equipment and systems as directed by the engineer. The warranty period shall not start until the equipment is turned over to the Owner for his use. The contractor shall provide extended warranties for parts and labor for all such equipment. Equipment shall not be turned over to the Owner until the temperature controls have been tested and accepted by the Owner and Engineer. Equipment shall be prepared and turned over to owner in as-new condition.

1.16 ROUGH-IN FOR FUTURE CONNECTION

A. Provide rough-in services for all systems which shall extend to future equipment or spaces as shown on the drawings.

1. Provide sufficiently sized branch plumbing lines with isolation valves to serve future equipment.
2. Provide sufficiently sized BMS/ATC master control panel(s) to accommodate a 20% increase in the number of equipment unit controllers and/or connected control points.

1.17 INSTALLATION GENERAL REQUIREMENTS

A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer's printed directions (maintained on job site during installation).

B. Provide all attachment devices and materials necessary to secure materials together or to other materials. Erect, install, and secure components in a structurally sound and appropriate manner.

C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.

D. Install materials only when conditions of temperature, moisture, humidity, and conditions of adjacent building components are conducive to achieving the best installation results.

E. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

F. Store and handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, rusting, or other disfigurement. Materials damaged for these reasons shall be replaced at no additional cost to Owner.

G. Conduct work in a manner to avoid injury or damage to previously placed work. Any work so impaired or damaged shall be replaced at no expense to Owner.

H. Fabricate and install materials true to line, plumb, and level.

I. Leave finished surfaces smooth and flat, free from wrinkles, warps, scratches, dents, and other imperfections.

J. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.

K. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best accepted practice in joinery and fabrication.

L. Consult Engineer for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.

M. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to "set". Mixing of a partially "set" batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.

N. In addition to the above refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

O. Piping or ductwork connected to equipment may require different size connection than indicated on the Drawings. The Contractor shall provide transition pieces as required at the equipment, at no additional cost.

1.18 SCAFFOLDING, RIGGING AND HOISTING

A. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of all equipment and materials furnished under this Section of the Specifications, and remove same from premises when no longer required.

B. In the event that supplementary bracing of the basic building structure is required to assure a secure rigging procedure and a secure route for the equipment being handled, assume full responsibility for such supplementary bracing.

1.19 TOOLS

A. All specified tools for proper operation and maintenance of the equipment shall be delivered to the Owner's representative and a receipt requested for the same at no additional cost to the Owner.

1.20 QUIET OPERATION

A. All equipment and material shall operate under all conditions of load without any sound or vibration which, in the opinion of the Architect, is objectionable. Where sound or vibration conditions arise which are considered objectionable by the Architect, eliminate same in a manner approved by the Architect.

1.21 RUBBISH REMOVAL

A. Clean all parts of the building exterior spaces and adjacent roads, sidewalks, and pavement, free from material and debris resulting from the execution of the work. Debris resulting from interior construction shall be neatly stacked on each floor near elevators, material hoists and rubbish chutes, as directed by the Architect or his representative. Debris resulting from exterior construction shall be similarly stacked. The General Contractor will remove all debris so stacked. Excess material will not be permitted to accumulate either on the interior, exterior or on the sidewalk.

1.22 DELIVERY OF MATERIAL

A. Deliver the material and store same in spaces indicated by the Architect and assume full responsibility for damage to structure caused by any overloading of the material or storage in spaces exposed to moisture, humidity, or other environmental conditions.

B. Hoods which will be duct-connected in the field shall be received and set in place by HVAC Contractor.

1.23 PAINTING

A. Paint all unpainted, non-insulated, non-galvanized, ferrous metal surfaces of pipes, conduits, ducts, equipment, fixtures, hangers, supports and accessories as follows:

1. Exposed and Concealed - one prime coat of primer and one coat of oil varnish based paint, color selected by Architect.
2. Underground - two coats of black asphaltum paint.
3. The inside of all ductwork where visible through openings shall be painted with two prime coats of dull black paint.

B. Nameplates on all equipment shall be cleaned and left free of paint. One finish coat of enamel color to be identified by architects.

PART 2 – PRODUCTS

2.1 QUALITY CONTROL

A. Manufacturers of equipment or materials will fall into one of the following categories:

1. "Basis of Design" - The manufacturer of equipment or materials listed on the Drawings or first named in the Specifications. If the Drawings and Specifications are in conflict, the drawings shall take precedence.

2. "Approved Equal" - Manufacturers whose products are listed in the Specifications under "Approved Equal"

3. "Substitution" - Manufacturers whose products are not listed in the Specifications.

B. Requirements applicable to all submittals:

1. Refer to Section 230502 / 2.2 - General Submittal Requirements

2. Provide Specification Compliance with all Submittals:

a. Contractor/Manufacturer shall submit the all relevant specification sections within the submittal indicating that they comply with each line item of each of the relevant specification section(s). For any item that doesn't comply, the contractor/manufacture shall clearly indicate why not and how their product meets or exceeds the requirement of that line item.

C. Requirements applicable to submission of "Approved Equals":

1. The submittal shall include a cover sheet indicating the following, signed by the contractor:

a. The proposed product will not affect dimensions shown on Drawings.
b. The contractor will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the submission.
c. The proposed product will have no adverse effect on other trades, the construction schedule, operation and maintenance, and specified warranty requirements.
d. Maintenance and service parts will be locally available for the proposed product.

2. The contractor shall be responsible for coordinating the required dimensions, clearances, access points and other service locations such that the submitted product properly fits in the available space allocated for the Basis of Design.

3. Provide all features which are standard on the Basis of Design, whether or not specifically specified or scheduled.

D. Requirements applicable to submission of "Substitutions":

1. Products by manufacturers not listed in the specifications may not be used as the basis of the bid price.

2. Substitution Request Form: Use Architect's Substitution Request Form, if one is not provided by the architect, utilize CSI Standard Form 13.1A.

3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

   a. Statement indicating why specified material or product cannot be provided.
   b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, dimension, durability, visual effect, and specific features and requirements indicated.
   d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   e. Operation, maintenance, and efficiency difference.
   f. Samples, where applicable or requested.
   g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   i. Research/evaluation reports evidencing compliance with building code in effect.
   j. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
   k. Cost information, including a proposal of change, if any, in the Contract Sum.
   l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
   m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

4. A/E will review Substitution Request and indicate one of the following actions:

   a. Substitution Request Approved as Noted - Make submittals in accordance with "Approved Equal" Requirements.
   b. Substitution Request Rejected - Use specified materials.

5. Under no circumstances should the substitution result in added cost to the project.

E. Shop drawings shall not be submitted prior to approval of all equipment submittals.

F. The materials, workmanship, design, and arrangement of all work installed under the Contract shall be subject to the approval of the Architect or Engineer.

G. If material or equipment is installed before it is approved, each trade installing same shall be liable for the removal and replacement at no extra charge to the Owner if, in the opinion of the Architect or Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.

H. It is the intent of these Specifications that wherever a “Basis of Design” manufacturer of a product is specified, the submitted item must conform in all respects to the “Basis of Design” specified item. Consideration will not be given to claim that the substituted item meets the performance requirements with lesser construction (such as lesser heat exchange surface, reduced horsepower, etc.). Performance as delineated in schedules and in the Specifications shall be interpreted as minimum performance.

I. Being listed in the specifications as a “Basis of Design” or “Approved Equal” manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.

J. All equipment and materials required for installation under these Specifications shall be new and without blemish or defect. All electrical equipment shall bear labels attesting to Underwriter's Laboratories approval. Where no specific indication as to the type or quality of the material or equipment is indicated, a first class standard article shall be furnished.

K. Where it is proposed to use an item of equipment other than specified “Basis of Design” which requires any redesign of the structure, partitions, foundations, piping, wiring, or of any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings and detailing required therefore shall, with the approval of the Architect or Engineer, be prepared at no additional cost to the Owner. On multiple prime contracts the substituting contractor shall negotiate with other prime contractors to have alternate work performed without cost to the owner.

L. All equipment of one type (such as fan coil units, etc.) shall be the product of the same manufacturer.

M. Note that the approval of shop drawings or other information submitted in accordance with the requirements hereinbefore specified does not assure that the Engineer, Architect, or any other Owner's representative attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the mechanical performance of equipment. Approval of shop drawings does not invalidate the Plans and Specifications if the shop drawings are in conflict with the Plans and Specifications.

N. With regard to proprietary or partially proprietary systems, including but not limited to building automation, automatic temperature controls, fire alarm, signaling, monitoring, data center alarm systems, etc., the specification of system components by a single manufacturer shall not be questioned. No discussion about inter-operability or open protocols will be considered. Contractor shall assume that engineer has previously considered substitutions of non-proprietary systems or open protocols and rejected this option.

2.2 GENERAL SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing:

1. Coordinate submittals 2 weeks (min.) prior to expected order date so that work will not be delayed by submittals.
2. No extension of time will be allowed because of failure to properly coordinate and sequence submittals.
3. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
4. Submittal is for information and record, unless otherwise indicated, and is not a change order request. Approval of alternate equipment or notations on shop drawings shall not be considered to be approval of additional cost.
5. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, temperature control, and test and balance subcontractors.
6. All submittals requiring expedited review shall be made at the start of the project. Submittals requiring expedited review due to delay of submission will be reviewed on engineering premium time which will be back-charged to the contractor.

B. Preparation of Submittals:

1. Refer to Division 1 requirements.
2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
3. Indicate any portions of work which deviate from the Contract Documents.
   a. Explain the reasons for the deviations.
   b. Show how such deviations coordinate with interfacing portions of other work.
4. Show Contractor's executed review and approval marking.
5. Provide space for Architect's/Engineer's "Action" marking.
6. Submittals which are received from sources other than through Contractor's office will be returned "Without Action".
7. Submittals shall be presented in a neat and legible fashion and shall be returned "Without Action" if presented in any other fashion.
8. Electronic submittals shall be subject to a minimum $50 document processing charge per submittal up to 50 letter size pages or 15 sq. ft. of wide format printing. Larger quantities will be subject to increased charges. Charges shall be deducted from payments to the Contractor by the owner.
9. Contractor is responsible for submission of shop drawings in accordance with plans and specifications for compliance with the system description and manufacturer. Shop drawings submitted, which are not in substantial compliance requires additional and unnecessary review time by the Engineer and Architect. Shop drawings submitted more than once, which are not in substantial compliance, shall be reviewed at a rate of $225 per hour and charged to the contractor. Charges shall be deducted from payment to the contractor by the owner.

C. Quantities: Unless otherwise indicated in Division 1, submit six copies.

1. Refer to Division 1 requirements.
2. Multiple System Items: Where a required submittal relates to an operation or item of equipment used in more than one system, increase the number of final copies as necessary to complete the Maintenance Manuals for each system.
3. Preliminary Submittal: Provide a preliminary, two-copy submittal for automatic temperature controls and when product data is required (or desired by Contractor) for selection of options by Architect/Engineer.
4. General Distribution:
   a. Provide additional distribution of submittals (not included in foregoing copy submittal requirements) to Subcontractors, Suppliers, Fabricators, Installers, Governing Authorities and others as necessary for proper performance of the work.
   b. Include such additional copies in transmittal to Architect/Engineer where required to receive "Action" marking before final distribution.
      1) Show such distributions on transmittal forms.

D. Response to Submittals: Where standard product data have been submitted, it is recognized:

1. That the Submitter has determined that the products fulfill the specified requirements.
2. That the submittal is for the Architect's or Engineer's information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submissions (either for shop drawings, as-built drawings, or test and balance reports) are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.

2.3 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS

A. Manufacturer's Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out significant portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
    a. Sizes
    b. Weights
    c. Speeds
    d. Capacities
    e. Piping and electrical connection sizes and locations.
    f. Statements of compliance with the required standards and regulations.
    g. Performance data.
    h. Manufacturer's specifications and installation instructions.
    i. Certified performance curves for all pumping and fan equipment shall be submitted for approval.
    j. Samples of materials or equipment, when requested by the Architect, shall be submitted for approval.
    k. Samples, drawings, specifications, catalogs, etc., submitted for approval, shall be properly labeled indicating project name, specific service for which material or equipment is to be used, Section and Article number of Specifications.
    l. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.
    m. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not in any was relieve responsibility, or necessity, of furnishing material or performing work as required by the Contract Drawings and Specifications.
    n. Prior to submission of shop drawings, thoroughly check each shop drawing, reject those not conforming to the Specifications, and indicate (by signature) that the shop drawings submitted meet Contract Requirements.
    o. All shop drawings showing routing of ductwork, piping and conduit, shall be not less than 3/8" = 1'0" scale.

B. Shop Drawings:

1. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale.
    a. Show clearance dimensions at critical locations.
    b. Show dimensions of spaces required for operation and maintenance.
    c. Show interfaces with other work, including structural support.

C. Test Reports:

1. Submit test reports which have been signed and dated by the firm performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.

D. Required equipment and shop drawing submittals:

1. Provide a submittal schedule with bid.
2. Provide equipment submittals for each item of equipment specified or scheduled in the contract documents.
3. Submittal Schedule shall show each item of equipment, applicable Section of the specifications where it is described, applicable Drawing number and schedule name where it is scheduled, date of Contractor's proposed submittal to Architect, required date to receive submittal from Architect and schedule order date.
4. Provide a Mechanical Shop Drawing Schedule for submission to the Architect with the Submittal Schedule.
5. Before request for acceptance and final payment for the work, write a letter to the Architect stating that all shop drawings are brought to a condition "Reviewed" or "Exception as Noted ". Any outstanding shop drawings must be cleared with the Engineer.

E. Submit shop drawings covering the following items:

1. Coordination drawings.
2. Internal cleaning and treating of piping.
3. Sleeve and ductwork penetration drawings.
4. Identification schedule and samples.
5. Air handling units, Energy recovery units, heat pumps.
6. Air filters and draft gauges.
7. Coils.
8. Humidifiers.
9. Heat exchangers.
10. Electric boilers.
11. Expansion joints, anchors and guides, including details of installation.
12. Air diffusers, registers and grilles.
13. Packaged and split systems.
14. Complete geothermal system with total capacity clearly indicated.
15. Schedule of ductwork, joints, gauges, supports, flexible connections, fire dampers, access doors, etc.
16. Utility fans, centrifugal fans, and power roof ventilators and propeller fans.
17. Sheet metal fabrication drawings.
18. Machinery guards and V-belt drives.
19. Roof vent fittings.
20. Schedule of piping and fitting materials.
21. Piping shop drawings.
22. Schedule of valves, strainers, vacuum breakers.
23. Schedule of steam pressure reducing valves.
24. Flow metering device and systems.
25. Thermometers and pressure gauges.
26. Automatic stop-check valves.
27. Expansion tanks.
28. Schedule of pipe and ductwork supports, including inserts, escutcheons, etc.
29. Heating systems, including unit heaters, cabinet heaters, fintube radiation, fan power boxes, convectors, etc., as specified.
30. Outside air supply unit including coils, filters, draft gauges, etc.
31. Heat recovery reclaim system.
32. Cabinet heaters, and unit heaters.
33. Water pumps including pump curves.
34. All motor starters and motor control devices.
35. Water treatment equipment and systems.
36. Schedule of insulation types and samples of each type.
37. Vibration isolation schedule including inertia block details.
38. Templates for equipment bases.
39. Acoustic material (internal duct lining).
40. VAV and constant air valve boxes.
41. Building management system.
42. Integrated room automation system.
43. Air vents, air separators, water strainers, reducing safety valves for water systems.
44. Diesel generator system.
45. Concrete pad location and size.
46. All air and water cooled condensers.
47. VRF condensers and evaporators, pipe and wiring diagrams, accessories.
48. All water source heat pumps.
49. Electric baseboard heaters and trench heaters.

F. All shop drawings being submitted that include electrical work shall be submitted with all internal and external wiring

diagrams.

G. The previously listed items are major equipment and do not limit this Division's responsibility to submit shop drawings for all equipment and accessories which are to be provided under this Division of the Specifications.

2.4 GREEN BUILDING REQUIREMENTS AND PERFORMANCE CRITERIA

A. Green Building Performance Criteria:

1. All field-applied concrete admixtures, adhesives, sealants, paints and coatings used for interior applications shall meet the volatile organic compound (VOC) and chemical component limitations as defined in architects specification or as required to obtain relevant LEED credit.

B. Green Building Submittal Requirements:

The Contractor and their sub-contractors shall submit the GREEN BUILDING CERTIFICATION items listed herein.

1. GBMCF: Submit a completed GREEN BUILDING MATERIALS CERTIFICATION FORM which will be provided by the architect or engineer. Information to be supplied for this form shall include:

   a. Cost breakdowns for the materials included in the Contractor or sub-contractor's work. Cost breakdowns shall include total cost plus itemized material costs for and VOC containing products.
2. Validation: Published product literature or manufacturer's letter of certification (on the manufacturer's letterhead) validating all information, other than costs, provided in the GBMCF.
3. Cut Sheets: Product cut sheets for materials listed in the GBMCF. Cut sheets shall be submitted with the Contractor or Trade Contractor's stamp, confirming that the submitted products are the products installed in the Project.
4. VOC Content: Material Safety Data Sheets (MSDS), published product literature, or manufacturer's signed certification (on manufacturer's letterhead) stating the VOC content of all applicable products.
5. Submittal Package: The GREEN BUILDING submittal information shall be assembled into one (1) package per Section or trade, and sent to the Consultant for review. Incomplete or inaccurate Green Building submittals may be used as the basis for rejecting the submitted products or assemblies.

2.5 COMPATIBILITY

A. General: Provide products which are compatible with other products of the mechanical work, and with other work requiring interface with the mechanical work.

B. Altitude Ratings: Except where noted otherwise, all ratings and capacities stated in the Contract Documents are at the altitude of the project.

C. Power Characteristics:

1. For power characteristics of equipment supplied under Division 21, 22 and 23 Sections, refer to the Sections of Divisions 26, 27 and 28 and the Electrical Drawings for the power characteristics of each power driven item of mechanical equipment.
2. Coordinate available power with Electrical Contractor before ordering equipment. Mechanical Contractor shall be responsible for ordering equipment to meet the available power characteristics.
3. See also Division 23 05 01 of these specifications.
4. If there is a conflict between Divisions 21, 22 and 23 documents and Divisions 26, 27 and 28 documents, alert the engineer. Do not order equipment prior to determining the proper electrical service. No contract cost adjustment will be allowed for equipment ordered in conflict with the available power characteristics.

2.6 SAFETY PROVISIONS

A. Equipment Nameplates: Provide power-operated mechanical equipment with a permanent nameplate attached by the manufacturer, indicating:

1. The manufacturer
2. Product name
3. Model number
4. Serial number
5. Speed
6. Capacity
7. Power characteristics
8. Labels of testing, listing, or inspecting agencies
9. Other similar data

B. Where manufacturer affixed nameplate is not available, Mechanical Contractor shall fabricate and attach nameplate.

C. Guards:

1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both side in a galvanized, one inch, mesh screen of No. 18 gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.
2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20 gauge galvanized steel over the coupling of each item of direct-driven equipment.

D. Refrigerant

1. Any refrigeration system containing any refrigerants listed in the Clean Air Act as a Class I or Class II Ozone Depleting Compound shall comply with the Clean Air Act.
2. As a minimum all systems shall be equipped with refrigerant recovery service valves, relief valves capable of resetting after activation, and for system with more than 50 pounds of charge, and isolateable receiver and/or condenser capable of holding the complete charge.
3. Any refrigerant removed from systems shall be recovered in accordance with Clean Air Act.

PART 3 – EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION

A. Inspection and Preparation:

1. Examine the work interfacing with mechanical work, and the conditions under which the work will be performed, and notify the Architect/Engineer of conditions detrimental to the proper completion of the work at original contract price.
2. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Layout:

1. Layout the mechanical work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire mechanical plant will perform as an integrated system, properly interfaced with other work, recognizing that portions of the work are shown only in diagrammatic form.
2. Where coordination requirements conflict with individual system requirements, comply with the Architect's or Engineer's decision on resolution of the conflict.
3. Take necessary field measurements to determine space and connection requirements.

4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.

C. Integrate mechanical work in ceiling spaces with suspension system, light fixtures and other work so that required performances of each will be achieved. Modification of duct work sizes from contract documents to sheet metal shop drawings for coordination purposes shall be included in the contractor's scope of work, confirm new ductwork dimensions with the engineer.

3.2 PRODUCT INSTALLATION

A. Manufacturer's Instructions:

1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. If a conflict exists, notify the Architect/Engineer in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:

1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
2. Otherwise, advise other Contractors of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:

1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
2. Where mechanical products to be installed on an existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

D. Return Air Path: Coordinate mechanical work in return air plenum to avoid obstructing return air path.

1. Do not make changes in layout which will reduce return air path cross-sectional areas. Minimum cross-sectional area will provide an average of 500 fpm and a maximum of 750 fpm velocity through return air plenum at specified supply air quantity unless otherwise noted.
2. Provide openings in any full height walls to allow for free movement of return air. Openings are to be sized for 500-750 fpm velocity. Provide fire or fire/smoke dampers at openings in fire rated walls, even if not specifically shown on the drawings.
3. Report any obstructions by work of other Divisions to Architect/Engineer.

E. Coordinate location of all floor mounted work (piping, ductwork, supports, etc.) in all areas (including mechanical rooms) to avoid obstruction of egress path.

F. Clearances:

1. Install piping and ductwork:
   a. Straight and true.
   b. Aligned with other work.
   c. Close to walls and overhead structure (allowing for insulation).
   d. Concealed, where possible, in occupied spaces.
   e. Out-of-the-way with maximum passageway and headroom remaining in each space.

2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:
   a. 8'-0" headroom in storage spaces.
   b. 8'6" headroom in other spaces; where approved by Architect.
3. Do not obstruct windows, doors or other openings.
4. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).

G. Access:

1. Provide for removal, without damage to other parts, of:
   a. Coils
   b. Humidifier manifolds
   c. Tubes
   d. Shafts
   e. Fan wheels
   f. Drives
   g. Filters
   h. Strainers
   i. Bearings
   j. Control components
   k. Other parts requiring periodic replacement or maintenance
2. Connect equipment for ease of disconnecting with minimum of interference with other work.
3. Provide unions where required.
4. Locate operating and control equipment and devices for each access.
5. Provide access panels where units are concealed by non-accessible finishes and similar work.
6. Extend all grease fittings to an accessible location.

3.3 PROTECTION OF WORK

A. All pipe ends, valves, ducts, and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage or the intrusion of foreign matter.

B. Do not allow any fans in the HVAC system to operate before the area served by the fan has been cleaned and vacuumed of all debris and dust which might enter the system.

C. Any equipment, duct or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Engineer's satisfaction.

D. Provide initial water seal fill for all waste P-traps, condensate traps, or similar traps.

3.4 PROTECTION OF POTABLE WATER SYSTEMS

A. All temporary water connections shall be made with an approved back flow preventer.

B. All hose bibs shall have as a minimum, a vacuum breaker, to prevent back flow.

C. Direct connections to hydronic systems shall only be made through a reduced pressure zone back flow preventer. Backflow drain shall be piped to drain to nearest floor drain or mopsink.

3.5 REFRIGERATION SYSTEMS

A. All techniques involved in the installation of refrigeration systems shall be by certified staff trained in accordance with the state and local requirements, and the applicable sections of the Clean Air Act.

B. No refrigerant shall be intentionally vented to the atmosphere. All refrigerant shall be recovered before opening a closed system for charging, evacuation or service. Equipment being demolished that contains R-170, R-290, R-600, R-600W, R-1150, R-1270 type refrigerants shall be subject to the approval of the commissioner of the Fire Department.

All refrigerant installed shall be new unless approved by the Engineer.

C. All refrigerant installed shall be new unless approved by the Engineer.

D. The Contractor shall be responsible and accountable for compliance with the EPA Clean Air Act (CAA) Section 608, 40 CFR Part 82 and any state or local codes for all refrigerant related work. In general, an EPA-certified technician shall perform any activity involving refrigerant-containing equipment that includes: (1) attaching and detaching hoses and gauges to and from refrigerant containing equipment to measure pressure; (2) adding refrigerant to, or removing refrigerant from equipment; or (3) any other activity that violates the integrity of a refrigerant containing circuit (for example any activity where a refrigerant containing circuit is 'opened' in any manner).

E. Refrigerant and oil shall be recovered from any equipment that does not meet the definition of a small appliance in 40CFR Part 82 Subpart F before removal and subsequent disposal. Small appliances (as defined in 40CFR Part 82 Subpart F) may be removed from the site with the charge (refrigerant) intact, provided it is properly labeled and handled in such a manner so as to prevent damage to coils. Small Appliances are defined in 40CFR Part 82 Subpart F as: Any appliance that is fully manufactured, charged, and hermetically sealed in a factory with five (5) pounds or less of a Class I or Class II substance used as a refrigerant, including, but not limited to, refrigerators and freezers (designed for home, commercial, or consumer use), medical or industrial research refrigeration equipment, room air conditioners (including window air conditioners and packaged terminal air heat pumps), dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

F. All new equipment installed shall utilize non-CFC refrigerants.

G. Prior to starting construction, demolition, or service work Contractor shall provide to Owner a list of all service technicians with EPA certification numbers and level of certification. (Copies of EPA certification cards are acceptable for those who will be working on the site.)

H. Contractor shall provide to the Owners Representative all Service Invoices (or equivalent service documentation acceptable to owner) for all work performed by EPA- certified Technicians. Service Invoices (or equivalent documentation) shall include the following information at a minimum for each piece of refrigerant containing equipment serviced:

- Date of Service
- Name of EPA-Certified Technician
- Technicians Certification Level
- Type of Equipment Serviced
- Equipment Manufacture
- Equipment Model and Serial Number
- Description of Service Performed
- Date Leak Discovered (if applicable)
- Date Leak Repaired (if applicable)
- Date Follow-Up Leak Test Performed (if applicable)
- Type of Refrigerant
- Normal System Full Charge (in pounds)
- Amount of Initial Refrigerant Charge Recovered During Service
- Amount of Recovered Refrigerant Returned to System
- Type of Additional Refrigerant Added to System
- Amount of Additional Refrigerant Charged to System
- System Charge at End of Service

I. Contractor shall provide Owners Representative a copy of complete manifests, invoices, or other documentation showing any refrigerant removed from the project by the contractor was disposed of appropriately or reclaimed by an EPA-certified Reclaimer.

3.6 LEAK TESTING

A. All new equipment not meeting the definition of a small appliance, including packaged equipment, factory charged, field charged, split systems or field-constructed systems with field-installed refrigerant piping shall be leak tested prior to or during startup. Leak testing shall utilize appropriate electronic leak-testing equipment.

B. Leak testing shall be conducted by an EPA-certified technician. The contractor shall provide written verification of the leak testing and results.

C. If a leak is detected, the following procedure shall be followed:

1. Notify the Owner's Site Representative (who will notify the Refrigerant Compliance Coordinator).
2. Document the leak.
3. Repair the leak.
4. Document the procedures followed.
5. Leak test to verify the leak was repaired.
6. Schedule and provide a 30-day follow-up verification leak test witnessed by a designated HVAC technician.
7. Document follow-up leak testing.
8. Repeat the above process if follow-up leak is detected.

3.7 DEMOLITION PROCEDURE FOR EQUIPMENT REMOVED BY CONTRACTOR

A. The Contractor, in contractor-provided refrigerant recovery cylinders, shall take ownership of the recovered refrigerant and transport off site to a proper disposal company or certified reclaimer.

B. Service Invoices, as described in RECORD DOCUMENTS, shall be provided.

C. The Contractor technician shall tag the unit that the refrigerant was removed.

D. Once an EPA-certified technician has removed the refrigerant and tagged the unit, a noncertified person may perform the remainder of the demolition.

3.8 START-UP

A. Tests shall be performed to the satisfaction of the Architect. The Architect will be present at such test, when he deems necessary and such other parties as may have legal jurisdiction.

B. Pressure tests shall be applied to piping only before connection of equipment and installation of insulation. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their rating.

C. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architect.

D. Any damages resulting from tests shall be repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architect.

E. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed in each Section of the Specification.

F. Equipment and systems which normally operate during certain seasons of the year shall be tested during the

appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated with and depends upon the operation of other equipment, systems and controls for proper operation, functioning, and performance, the latter shall be operated simultaneously with the equipment or system being tested. Provide any temporary devices required to complete start-up of equipment where that system's installation is incomplete at the time of start-up.

G. The electrical work shall include providing any assistance (such as removal of switchboard and panelboard trims and covers, pull and junction box covers, etc.) deemed necessary by the Architect to check compliance with the Drawings and Specifications.

H. The Contractor shall assign a Plumbing, Fire Protection and HVAC Start-Up Coordinator to this project.

I. The Start-Up Coordinator shall develop detailed start-up procedures, equipment checkout procedures and data forms for recording compliance with contract document performance criteria, and will assist in developing schedules for checkout and Owner acceptance.

J. The Plumbing, Fire Protection and HVAC Contractors shall include as part of the work of this contract, manpower, equipment, tools, ladders, instruments, etc. necessary to confirm start-up of Plumbing, Fire Protection and HVAC systems.

K. The Test, Adjust and Balancing Contractor shall include as part of the work of his/her contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to assist the Start-Up Coordinator in accomplishing his/her work.

L. The Start-Up Coordinator shall be responsible for maintaining documentation of Start-Up activities until final acceptance of the project.

M. The documentation shall be kept current by the Start-Up Coordinator and shall be available for inspection at all times. At the time of acceptance of the project, the Start-Up Coordinator shall surrender 3 completed copies of the documentation to the Owner's representative.

N. Before Testing, Adjusting, Calibration and Balancing, the Start-Up Coordinator shall confirm, in writing to the Owner, the following:

1. All equipment, components, and systems have been set, started-up, and adjusted.
2. Systems have been established at the appropriate temperatures and pressures for proper operation and performance.
3. All electric power connections, disconnects, fuses, circuit breakers, etc. are properly sized and installed.
4. The operation of all valves, dampers and sensors is positive (per the control sequences) and demonstrated.

O. Provide dated matrices for each item of equipment showing the date each of the start-up activities was witnessed or performed by the Start-Up Coordinator.

1. Start-up and operating performance test documentation shall include all Division 21, 22 and 23 equipment with scheduled or rated capacities.

P. At the completion of the start-up; and test and balance, Plumbing, HVAC and Fire Protection contractors shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner and Architect/Engineer. Contractor shall be available during the period to adjust equipment operation or setpoints. The engineer may direct the contractor to implement new control sequences or alter system installation in response to data collected during start-up. Work that can be completed by staff assigned to start-up that can be completed in the time period assigned to the start-up shall be completed with out additional cost to the owner.

Q. The Owner may require operation of parts or all of the installation for the beneficial occupancy to final completion and acceptance of the building. The operation shall not be construed to mean acceptance of the work by the Engineer

for the Owner. The Owner will furnish supervisory personnel to direct operation of the entire system and the Contractor shall continue to assume this responsibility until final acceptance.

3.9 DEMONSTRATION

A. Refer to Architectural sections of the specifications regarding requirements of Record Drawings and Operation and Maintenance Manual submittal and systems demonstration.

1. Demonstrate to the Architect/Engineer that each system operates in accordance with the contract documents.
2. Explain the operation of each system to the Owner's Representative. Explain use of O&M manual in operating and maintaining systems.

B. Date and time of demonstration will be determined by Owner.

C. Demonstration Requirements.

1. Provide a point-to-point check-out of 100% of BMS controlled points for all equipment.

3.10 PROJECT CLOSEOUT

A. Refer to the individual sections of the specifications for individual closeout requirements.

B. Provide a written schedule of when systems are to be started up, tested and demonstrated along with dates for completion of the temperature controls and balancing. This schedule shall be submitted no later than 30 days prior to starting up and testing equipment.

C. The contractor shall notify the Architect/Engineer no later than 2 weeks in advance of system testing or demonstration.

END OF SECTION

SECTION 23 05 03

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

B. Where contradictions occur between this Section and Division 1, the most stringent of the two shall apply. The design team shall decide which is most stringent.

C. Provisions of this Section shall also apply to all Sections of Divisions 21, 22 and 23.

1.2 SUBMITTALS

A. Manufacturer's Data - Submit manufacturer's data for:

1. Access panels.
2. Fire stopping materials.
3. Heat Trace.

B. Application Data - Submit application data for firestopping materials showing UL required installation details for every combination of pipe material, penetrated structure, opening size and required fire rating within the scope of this project. Application data drawings shall include UL system number.

PART 2 – PRODUCTS

2.1 ACCESS PANELS

A. See Architectural specification for access panel types and finishes.

1. If panels are not specified in architectural specification, comply with the following:
   a. Manufacturers:
      1) Design Basis: Milcor Division, Inryco, Inc.
      2) Other Acceptable Manufacturers:
         a) Birmingham Ornamental Iron Co.
         b) Karp Associates, Inc.
         c) Wilkenson Co., Inc.

B. Construction:

1. Doors: 14 gauge steel.
2. Frames: 16 gauge steel.
3. Fire Rating: Equivalent to construction in which installed.
4. Latches: Flush or concealed, ¼ turn.
5. Finish: Selected by Architect.

2.2 FIRE STOPPING MATERIAL

A. Manufacturers:

1. Design Basis: 3M.
2. Other acceptable manufacturers:
   a. GE
   b. Metalines
   c. Hilti

B. General Requirements:

1. Products to be used shall have been tested in accordance with ASTM E 814-88, and be listed in the UL Fire Resistance Directory.

C. Bare Piping:

1. Model: FD 150, or CP-25.

D. Insulated Piping:

1. Model: CP-25 or FS-195, Intumescent.
2. “No-sag” or “self-leveling” as required.

E. Accessories:

1. Provide fasteners, restricting collars, backing materials, and protective coatings as required to comply with the UL system listing.

2.3 SPARE PARTS

A. Geothermal and solar thermal pumps - For each pump listed, unless otherwise specified.

1. One set of wearing rings or seals.
2. One set of bearings.
3. One set of packing glands complete with rings, nuts and bolts.
4. Three gaskets for casing joint.
5. Sufficient stuffing box packing for four packings.

Where pump specifications do not require mechanical seals, packing glands or stuffing boxes, spares listed may be omitted. Spare set of seals shall be provided.

B. Filters

1. The Contractor shall furnish a minimum of 2 complete spare filter sets for the filters for all units.

C. Heat Pump Spare Parts

1. Provide one complete compressor section for each vertical heat pump size used in the guest rooms and suites. Compressor section shall be complete and easily exchanged for replacement/repair.

D. Miscellaneous Spare Parts

1. Water column glasses shall be provided for each tank utilizing one.
2. Furnish one complete set of V-belts for each belt driven unit installed.
3. A full set of spare fuses for each VFD drive.

2.4 ESCUTCHEONS

A. Provide escutcheons on pipes wherever they pass through ceilings, walls, floors, or partitions.

B. Escutcheons or pipes passing through outside walls shall be Ritter Pattern and Casting Co., No. 1, solid, cast brass, flat type secured to pipe with set screw.

C. Escutcheons for pipes passing through floors shall be Ritter Pattern and Casting Co., No. 36A, split-hinged, cast brass type, designed to fit pipe on one end and cover sleeve projecting through floor on the other end.

D. Escutcheons for pipes passing through interior walls, partitions, and ceilings shall be Ritter Pattern and Casting Co., No. 3A, split-hinged, cast beams chromium plated type.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Quality Coordination: Where excavation and backfill for mechanical work passes through or occurs in the same area as work specified in Division 2, comply with both the requirements of Division 2 and the requirements of this Section, or whichever is the more stringent (as determined by the Architect/Engineer in cases of conflicting requirements).

B. Inspection:

1. Examine the areas to be excavated, and the conditions under which the work is to be performed.
2. Notify the Architect/Engineer in writing of conditions detrimental to the proper completion of the work.
3. Do not proceed with excavating until unsatisfactory conditions have been corrected.

C. General:

1. Do not excavate for mechanical work until the work is ready to proceed without delay, so that the total time lapse from excavation to completion of backfilling will be minimum.
2. Remove all rock and boulders from excavation before installing mechanical work.
3. Slope sides of excavations as required for stability, or provide necessary shoring.
4. Remove shoring during backfilling.
5. Excavate near large trees (within the drip line) by hand.
   a. Protect the root system from damage or drying to the greatest extent possible.
   b. Maintain moist condition for root system and cover exposed roots with burlap.
   c. Paint root cuts of 1” diameter and larger with asphaltic tree paint.
6. Saw-cut asphalt and concrete surfaces.

D. Depth of Excavation:

1. Depth for Exterior Piping: Except as otherwise indicated, excavate for exterior piping so that the vertical distance between top of piping and finished grade will not be less than 5’-0”.
2. Depth for Unsatisfactory Soil Conditions:
   a. Where directed, because of unsatisfactory soil condition at bottom of excavation, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with “squeegee” washed rock, or other approved sub-base material, compacted as directed, to indicated excavation depth.

b. Where piping crosses over an area more than 5'0" wide, which has been previously excavated to a greater depth than required for the piping installation:
   1) Excavate to undisturbed soil in a width equal to the pipe diameter plus 2'0".
   2) Install "squeege" washed rock, or 8" courses of approved subbase material; each course compacted to 95% of maximum density, as required to fill excavation and support piping.

E. Protection:

1. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.
2. Coordinate excavations with weather conditions, to minimize the possibility of washouts, settlements and other damages and hazards.
3. Allow no more than 100 feet between pipe laying and point of complete backfilling.
4. Maintain dry excavations for mechanical work by removing water.
   a. Protect excavations from inflow of surface water.
   b. Pump minor inflow of ground water from excavations.
   c. Protect excavations from major inflow of ground water by installing temporary sheeting and waterproofing.
   d. Provide adequate barriers which will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through mechanical work excavations.
5. Provide signs, illumination and barricades as necessary to prevent accidents at excavations.
6. Install and operate a well-point dewatering system to maintain ground water at a level approximately 2'0" below mechanical work excavations, until backfilling is completed.

F. Excavated Material:

1. Store excavated material (temporarily) near the excavation, in a manner which will not interfere with or damage the excavation or other work. Do not store under trees (within the drip line).
2. Retain excavated material which complies with the requirements for backfill material.
3. Remove excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material from project site, and dispose of in a lawful manner.
4. Coordinate acceptable stockpiling areas with Owner in advance of excavation.

G. Bedding:

1. Where indicated below, install as bedding material graded sand with 100% passing through a 3/8" sieve, and 0% passing through No. 100 sieve.
   a. Compact by tamping to form a firm base for the work.
   b. Install bedding from six inches below bottom of pipe to six inches above top of pipe.
   c. Provide bedding for:
      1) Wrapped, coated or plastic pipe and tanks.
      2) Piping over six inches, horizontal cylindrical tanks, and similar work.
         a) Shape the subbase to fit the shape of the bottom 90º of the cylinder, for uniform continuous support.
      3) All water and sewer pipe.
2. Where rock is used as sub-base, place 8-mil polyethylene between rock and bedding.
3. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flange connection, valves and similar enlargements in the piping systems.

H. Concrete Encasement: Where piping under roadways is less than 2'6" below surface of roadway, or where ductwork is buried below grade:

1. Provide 4" base slab of concrete to support piping and ductwork.

2. After piping or ductwork is installed and tested, provide 4" thick encasement (sides and top) of concrete before backfilling.
    a. Provide external structural reinforcing of all rectilinear cross section ductwork or any ductwork which is less than 18 ga sheet metal (or equivalent) to prevent collapse of ductwork encasement.
3. Provide minimum 2500 psi concrete for encasement and slab.

I. Backfilling:

1. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
2. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities.
3. Do not backfill with frozen soil materials.
4. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously.
5. Do not dislocate the work from installed positions.
6. Backfill to elevations matching adjacent grades, at the time of backfilling excavations for mechanical work.
7. Backfill with finely graded sub-base material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
8. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the densities indicated in Division 2 using power-driven, hand-operated compaction equipment.
9. If densities are not indicated in Division 2, compact to the following percent of maximum per ASTM D1557:
    a. Lawn/Landscaped Areas: 85%.
    b. Paved Areas, Other than Roadways: 90%.
    c. Roadways: 95%.
    d. Floors: 95%.
10. Where compaction tests indicate lower densities of backfill than specified, continue compaction (and re-excavation and backfilling where necessary).
    a. Provide additional testing as directed by the Architect/Engineer.
    b. The allowable density tolerance is not more than one-test-out-of-five failing more than two percentage points below the specified density.
    c. Initial testing is not work of this Section.
11. Where subsidence is measurable or observable at mechanical work excavations during the guarantee period:
    a. Remove the surface (pavement, lawn or other finish).
    b. Add backfill material, compact, and replace the surface treatment.
    c. Restore the appearance, quality and condition of the surface or finish to match adjacent work.
    d. Eliminate evidence of the restoration to the greatest extent possible.

J. Landscape Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in a landscaped area, repair or replace the landscape work to match the original condition and quality of the work.
2. Comply with the requirements of Division 2 for repair or replacement of work, and for follow-up maintenance on lawns and planting to ensure satisfactory recovery.

K. Pavement Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in an area of paving or flooring, replace and restore the construction and finish of the paving or flooring to match the original condition and quality of the work.

L. Surface Repairs:

1. The repairing and replacing of previously installed landscape development work, paving, floor slabs and similar finishes occurring in excavated areas shall be provided, but is not included in work of Divisions 21, 22

and 23.

3.2 CUTTING AND PATCHING

A. Refer to Architectural sections of the Specifications for additional requirements.

B. Provide measurements, drawings and layouts to installers of other work so that required openings may be provided as construction progresses. Any cutting and patching made necessary by failure to provide this information shall be done at no increase in the contract amount.

C. All cutting and patching of existing work required for Plumbing, HVAC and Fire Protection work is included in the scope of the plumbing, HVAC and Fire Protection contracts. Finish patching, painting and restoration of finishes outside of primary work area is the Plumbing, HVAC and Fire Protection contractor performing work. Finish patching, painting and restoration of finishes in primary work area is by others. Rough patching, finish patching, painting and/or restoration of finishes outside of the primary work area is by each trade contractor.

D. Where possible, mark openings to be cut on existing construction. Otherwise, provide measurements, drawings and layouts to the trade doing the cutting so that openings may be provided as construction progresses.

E. Cutting Concrete:

1. Where authorized, cut openings through concrete for pipe penetration and similar services by core drilling or sawing.
2. Do not cut by hammer-driven chisel or drill.

F. Cutting:

1. Cut openings in accordance with layouts, measurements or drawings of the Installer of work requiring openings. Cut openings in concrete by core drilling or sawing; not by hammer-driven chisel or drill.
2. Coordinate the location of all openings with structural drawings. Report any discrepancies to Architect. Do not proceed with work until discrepancies have been resolved.
3. Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work.
4. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage.
5. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

G. Patching:

1. Where patching is required to restore other work because of either cutting or other damage inflicted during the installation of mechanical work, engage experienced craftsmen to complete the patching of the other work.
2. Restore the other work in every respect, including the elimination of visual defects in exposed finishes.
3. All openings in fire rated construction shall be patched and sealed with U.L. approved sealant to maintain the fire integrity of the structure.

H. Perform cutting, patching and restoration of finishes required to:

1. Uncover work to provide installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.

6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineers observation of concealed work.

I. Painting:

Paint all surfaces marred by cutting and/or patching to match existing.

1. Engage experienced painters.
2. Comply with requirements of Painting Sections of the Specification.

J. Structural Limitations:

1. Do not cut or drill into structural framing, walls, floors, decks, and other members intended to withstand stress, except with Engineer's written authorization.
   a. Provide lintels, columns, braces and other temporary and permanent supports made by cutting.
   b. Submit shop drawings of permanent supports.
   c. Do not penetrate legs of structural "T's" or any other location where pre-stressed structural chords are likely to be encountered when cutting or drilling.

K. Provide inspection via metal detector or x-ray to identify existing concealed utilities when existing conditions make it apparent that concealed utilities may exist.

3.3 ACCESS PANELS

A. Furnish access panels where indicated and at locations where required for access to:

1. Concealed valves
2. Dampers
3. Control devices
4. Equipment servicing
5. Shock arresters
6. Air vents
7. Flow measuring and balancing stations
8. Any other device or item equipment requiring maintenance, adjustment or service.

B. Deliver access panels for installation by the trade responsible for surface in which installed.

1. Provide instructions for location.
2. The minimum size for access doors shall be the larger of 24"x24" or to fit the size of equipment to be removed.
3. If calculation of required access doors under item A above identifies less than 1 access door per 200 square feet of ceiling and wall construction, the quantity of access doors shall be increased to 1 per 200 square feet of ceiling and wall construction.

C. See "mechanical and electrical coordination" for additional access door requirements if section has been included in this specification.

3.4 SLEEVES

A. Provide sleeves for piping passing through walls, floors and roofs.

B. Provide sleeves for existing-to-remain piping through new walls.

C. Set pipe sleeves and inserts in place before concrete is poured. Coordinate the placing of these items to avoid delaying concrete placing operations.

D. Locate chases, shafts, and openings required for the installation of the mechanical work during framing of the structure. Do any additional cutting and boring required due to improperly located or omitted openings without cost to the Owner under the supervision of the Owner's representative.

E. Size sleeves for below grade pipe a minimum of 2" beyond outside of pipe.

F. Coat surface of all sleeves in contact with concrete, masonry or soil with two coats of coal tar bitumastic paint.

G. Provide Sleeves as Follows:

Sleeve Location	Sleeve Material
Interior Stud Partition Walls	Adjustable galvanized sheet metal with wall flanges and plaster lip, 2" and smaller – 22 gauge, 3" through 6" – 20 gauge, 8" and larger – 18 gauge.
Membrane Waterproof Floor and Roof Construction	Galvanized cast iron body with flashing clamp, threaded for sleeve riser. (J.R. Smith 1760 or equivalent by Ancon, Zurn or Josam).
Nonmembrane Floor, Construction	Non-adjustable galvanized sheet metal with deck flange and end cap, 2" and smaller – 22 gauge, 3" – 20 gauge, 4" and larger – 16 gauge.
Exterior Walls Below Grade	Standard weight galvanized steel pipe with a continuously welded water stop of ¼" steel plate extending from outside of sleeve a minimum of 2" all around. Provide modular mechanical–type seal consisting of interlocking synthetic rubber links with bolts shaped to continuously fill the annular space between the pipe and sleeve. Thunderline Corporation "Link-Seal" sealant assembly or equal by Metraflex "MetaSeal".
Floors of Mechanical Rooms, Concrete Walls or Masonry Walls Above Grade.	Standard weight galvanized steel pipe.

H. Length of Sleeves as Follows:

Location	Sleeve Length
Floors	Equal to depth of floor construction including finish. Extend minimum of 1" above finished floor level within partitions, mechanical rooms, pipe chases and finished areas.
Roofs	Equal to depth of roof construction including insulation. Extend to 2" above maximum flood depth where rooftop retention is provided.
Walls	Equal to depth of construction.

3.5 FIRE STOPPING

A. Install firestopping materials in accordance with their UL and ASTM tested methods.

B. Coordinate required annular space with size of pipe and sleeve.

C. Requirements for specific systems:

1. Cold piping - includes chilled water, domestic water, storm water and refrigerant: Insulation and vapor barrier shall be continued through wall and firestopping for “insulated piping” shall be provided.
2. Hot piping - to 250ºF -includes domestic hot water, steam to 15 psig and heating hot water: The Contractor has the option of continuing the insulation through the penetration and providing firestopping for “insulated piping”, or stopping the insulation on either side of the penetration and using firestopping for “uninsulated piping”.
3. High temperature piping, over 250ºF or over 15 psig steam: Contractor shall stop insulation and provide firestopping for high temperature piping.

3.6 EQUIPMENT BASES AND SUPPORTS

A. Supporting Steel: Provide supporting steel not indicated on the Structural Drawings for equipment, pipe ductwork, and other pieces of this Division’s work requiring same.

1. Submit shop drawings and structural calculations to the Engineer for information and records.
2. Brace and fasten with flanges bolted to structure.
3. Paint supporting steel with one coat of primer paint in the shop after fabrication welding is complete. Paint completed field joints with one coat of matching primer.

B. Housekeeping Bases:

1. Concrete bases for pumps, boilers, tanks, fans, etc., including anchor bolts and inserts, will be provided in accordance with American Concrete Institute (ACI) and American Society for Testing and Materials (ASTM) Standards for housekeeping pads and equipment support bases.
2. The concrete shall be placed in accordance with setting diagrams and sizes furnished by the equipment installer.
3. The Section furnishing the equipment shall provide not less than 4" high concrete bases for all pumps, refrigeration machines, compressors, and rotating machinery. Bases shall extend six inches beyond machinery base in all directions, with top edge chamfered. Provide 1/2" x 6" steel dowels into floor to anchor bases. Provide anchor bolts set in pipe sleeves, two sizes larger than anchor bolts for securing machinery. After anchor bolts are aligned with equipment bases, fill sleeves with concrete and allow to set.

3.7 RAILINGS

A. Where railings and guards are not provided in another section of the specification, each contractor shall provide protection as described below for all equipment installed by the contractor.

1. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof, or grade below.
2. The guard shall extend not less than 30 inches beyond the end of such appliance, equipment, fan or component.
3. The top of the guard shall be located not less than 42 inches above the elevated surface.
4. The guard shall be constructed so as to prevent the passage of a 21-inch-diameter sphere and shall comply with the loading requirements for guards specified in the local Building Code.

3.8 DRIP PANS

A. Drip Pans:

Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above electrical (or electronic) work which is sensitive to moisture. Otherwise, provide drip pans under mechanical piping, sufficient to protect electrical work from dripping.

1. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 18" beyond equipment being protected.
2. Fabricate pans 2" deep of reinforced 22 gauge galvanized sheet metal with rolled edges and welded seams.
3. Provide ¾" copper drainage piping from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection.
4. Provide permanent support and anchorage to prevent displacement of drip pans.
5. Insulate bottom of pan where pan is subject to the frequent discharge of water or materials less than 60˚F.

END OF SECTION

SECTION 23 05 13

MOTORS AND STARTERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data.

1. Motors: Identify by unit served. Include:
   a. Voltage
   b. Phase
   c. Horsepower
   d. Frame
   e. Insulating class
   f. Efficiency
   g. Power factor
   h. Index number
   i. Speed
   j. Starting characteristics
2. Starters: Identify by motor served. Include:
   a. Enclosure, NEMA Type
   b. NEMA size
   c. Accessories, switches, transformers, etc.
   d. Wiring diagram
   e. Auxiliary contacts
   f. Thermal overload size
3. Submit as part of packaged unit submittals when purchased as part of item of equipment.

1.2 SINGLE MANUFACTURER

A. Provide all motors, except those factory mounted, by a single manufacturer.

B. Provide all starters, except those factory mounted, by a single manufacturer.

C. "Factory mounted" means "as part of a packaged unit" where the motor is not purchased separately from the driven equipment.

PART 2 - PRODUCTS

2.1 MOTORS (OTHER THAN FACTORY MOUNTED)

A. Manufacturers:

1. Design Basis: Reliance
2. Other Acceptable Manufacturers:
   a. General Electric
   b. Westinghouse
   c. U.S. Motor
   d. Magnetek
   e. Baldor

f. U.S. Electric

3. Factory mounted motors may be by equipment manufacturer's standard supplier.

B. Bearings: Ball bearings, grease lubricated with grease fittings.

C. Enclosure: As required by location.

D. Service Factor: 1.15.

E. Full-Load Operation: At 105ºF and altitude of project.

F. Overload Protection:

1. Type: Trip-free thermal overload relay.
2. Location: Each ungrounded conductor.
3. Reset: Manual.
4. Ambient Temperature Compensation: Provide where required.
5. Overload protection to be sized for nameplate running amps.

G. Insulation:

1. Constant Speed: Class B.
2. Variable Frequency Controlled: Class F.

H. Efficiency Ratings:

1. All motors one horsepower and larger, except as noted, shall be premium efficiency motors, in accordance with NEMA Standard MGI-2003, Tables 12-12 and 12-13.

I. Electrical Characteristics:

1. Refer to sections 23 05 01, Mechanical and Electrical Coordination.
2. Motors less than ½ hp shall be 115-volt single phase.
3. Motors ½ hp and larger shall be three phase, of voltage shown in Electrical Section of Contract Documents.

J. Multi-speed Motors:

1. Type: Motors may be one of the following:
   a. Two speed, two winding 1800/900 rpm.
   b. Two speed, one winding 1800/900 rpm.

K. Variable Speed Drives:

1. All motors operated by a variable speed drive shall be rated for inverter duty.
2. Motor insulation shall be rated for 1600-volt peak.
3. All motors need to be NEMA MG-1, Part 31 compliant.
4. Refer to VFD specification for additional requirements if included in this specification.
5. Provide AEGIS shaft grounding rings for all motors operated by a VFD.

2.2 MOTORS (FACTORY MOUNTED)

A. Provide premium efficiency motors.

B. Variable Speed Drives:

1. All motors operated by a variable speed drive shall be rated for inverter duty.
2. Motor insulation shall be rated for 1600 volt peak.
3. All motors need to be NEMA MG-1, Part 31 compliant.
4. Refer to VFD specification for additional requirements if included in this specification.
5. Provide shaft grounding rings for all motors operated by a VFD.

2.3 STARTERS

A. Manufacturers:

1. Allen Bradley
2. Cutler-Hammer
3. General Electric
4. Square D

B. General:

1. Starters shall be standard NEMA sizes and UL listed.

C. Type: Across the line except where noted.

D. Enclosure: NEMA Type as required for location. Provide stainless steel enclosures in wash down areas, kitchens, dishwasher areas, exterior spaces, and any other areas where equipment will be exposed to moisture. Provide space heater and any necessary transformer within the enclosure as required to maintain the minimum internal temperature required by the manufacturer.

E. Overload Protection:

1. Type: Trip-free thermal overload relay for each ungrounded conductor.
2. Reset: Manual.
3. Ambient Temperature Compensation: Provide where required.
4. Overload protection to be sized for nameplate running amps.

F. Auxiliary Contacts:

1. Number: Provide three per starter as required for control sequence, and one (1) auxiliary contact.
2. Switchable type, easily changed from N.O. to N.C. without removing from its mounting.

G. Switches in Cover:

1. Manually Controlled: Three wire start-stop.
2. Automatically Controlled: Hand-off-automatic.
3. Start and stop indicating lights.
4. Equipment used for life safety (smoke exhaust, etc.): Hand-Automatic.
5. Equipment not designed to run continuously: Off-Automatic.

H. Control Transformer:

1. Provide when line voltage exceeds 208 volts.
2. Secondary wiring shall have one leg fused and the other grounded.
3. Secondary voltage not to exceed 120 volts.

I. Provide starters for all motors as follows:

1. Single phase motors less than ½ hp.
   a. With internal overload protection: None.
   b. Without internal overload protection:
      1) Manually Controlled: Manual starter.
      2) Automatically Controlled: Magnetic starter.
2. Single phase motors ½ hp and larger:
   a. Manually Controlled: Manual starter.
   b. Automatically Controlled: Magnetic starter.
3. Three Phase Motors: Magnetic starter.

J. Soft Start Starters:

1. Provide Y-Delta or solid state reduced voltage starters for all motors 50hp and larger.
2. Starter shall limit starting voltage to 200% of full load voltage.

K. Multi-Speed Starters:

1. Starters shall be suitable for the type multi-speed motor selected.
2. Provide time delay for automatic transfer from high to low speed.

L. Housing coils to be 120V.

M. Motor Protection: (above 20 hp)

1. Provide Single-phase protection.
2. Provide under-voltage protection.

N. Disconnecting Means

1. Provide combination starters-disconnects for all starters unless specifically stated otherwise.

PART 3 - EXECUTION

3.1 MOTORS

A. Install motors on motor mounting systems so coupling or belt drive is properly aligned. Provide proper belt tension. Dowel direct coupled motors.

B. Field quality control: Fun each motor to demonstrate rotation, speed, current draw meets nameplate, etc.

C. Requirements for storage, handling and protection: Keep motor windings protected and clear of dust.

3.2 STARTERS

A. Deliver to installer of electrical work.

B. All safety devices shall be wired so that they will stop the motor with a hand-off-automatic switch in the hand as well as the automatic position.

END OF SECTION

SECTION 23 05 19

ENERGY METERING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. In addition to the work covered under this section, comply with description of individual systems under other sections of the Specifications.

PART 2 - PRODUCTS

2.1 BTU METERING STATIONS

A. Provide BTU demand and consumption metering stations on the geothermal and condenser water systems and as indicated on the drawings. Meters shall be of either ultrasonic type, or electromagnetic insertion type. Meter shall be capable of accurate measurement while operating under design water flow turndown ratios as shown on the drawings, as specifically approved by the Architect, and under actual water flow conditions.

B. Thermal Energy Meter

1. Provide complete Thermal Energy (BTU) Measurement System including micro-processor based BTU meter, flowmeter, matched set of temperature sensors and mechanical installation hardware and cabling required for a complete system installation. BTU measurement system shall be configured for the specific application prior to delivery.
2. BTU meter shall be constructed, calibrated and scaled for the intended application in terms of pipe size, pipe material, installation requirements, expected energy rate, ambient conditions and fluid characteristics which include but are not limited to pressure, temperature and viscosity.
3. Total thermal energy measurement (BTU) system to be provided by a single manufacturer, including flowmeter, temperature sensors and BTU meter.
4. Design
    a. BTU Calculator
        1) Computation error </= 0.09% @ 30-degree F delta T
    b. Enclosure
        1) NEMA 12K enclosure minimum, designed for wall or DIN rail mounting. Non-metallic enclosure materials of construction must meet UL 94 V-0 flammability requirements and be suitable for use in plenum spaces.
    c. Connections
        1) Provide three (3) ½" conduit access holes minimum
    d. Ratings
        1) Pressure: N/A
        2) Temperature: -13 F to 140 F ambient
5. Operations and Configuration:
    a. Temperature Sensor Accuracy:
        1) Provide a matched pair of 1000 Ohm platinum RTDs, wet calibrated to a differential measurement uncertainty of +/- 0.18-degree F over the stated range. RTD's must meet EN1434/C900 accuracy requirements for 3K sensors.
    b. Calibration and Configuration:

1) Each thermal energy (BTU) metering system shall be factory programmed for the specific application and each metering system component, including temperature sensors and flow meter, shall receive a certificate of calibration, directly traceable to N.I.S.T.

c. Transmitter and Display
1) Provide an operator interface consisting of four push-buttons and graphical interface. Display shall visually indicate total fluid volume in gallons, instantaneous flow rate, supply temperature, return temperature, thermal energy flow rate and thermal-energy flow total in kilowatts per hour or British thermal units (BTU). Output signals shall be RS485 serial network protocol, native BACnet MS/TP or MODBUS RTU, three (3) programmable pulse outputs and one (1) analog output signal. Meter shall have the capability to receive and totalize three (3) auxiliary input pulses which can be viewed locally and communicated over the RS485 network.

d. Listings and Certifications
1) Meter shall have FCC: Part 15, Subpart B
2) Meter shall have CE approval
3) Meter shall be UL listed
4) Meters selected with BACnet shall have BTL Certification to ASHRAE 135:2009

6. Manufacturer:
a. Basis of Design: Onicon System 20
b. Alternate Manufacturers:
1) Panametrics
2) Siemens

C. Flow Meter
1. Provide an insertion electromagnetic flowmeter complete with NIST traceable, wet calibrated flow-measuring element, integral transmitter, installation valves, installation depth gage and calibration certificate. Flowmeter shall be wet tappable, allowing insertion and removal from the flow stream without system shutdown. Onicon Model F-3500 Series or approved equal.
2. Flowmeter shall be constructed, calibrated and scaled for the intended application in terms of pipe size, pipe material, installation requirements, expected flow rate, ambient conditions and fluid characteristics which include but are not limited to pressure, temperature, conductivity and viscosity.
3. Design:
a. Electromagnetic velocity-measuring element. Element shall utilize two sets of diametrically opposed electrodes to measure the average flow rate velocity
b. Construction
1) Wetted components shall be constructed of 316L stainless steel with attached tag indicating calibration information.
2) 1” Male NPT Hot Tap Adapter fitting. Installation through 1” full port isolation valve, minimum.
c. Ratings
1) Maximum Pressure: 400 psig
2) Maximum Temperature: 200 F
4. Flow-measuring element and transmitter shall cover operating range of equipment or system served.
5. Flowmeter shall provide calibrated outputs directly from the integral transmitter, throughout the operating range with the accuracy stated as follows:
a. ± 1.0% of rate from 2.0 to 20.0 ft/sec velocity (10:1 turndown)
b. ± 0.02 ft/sec below 2 ft / sec
6. Each flowmeter shall receive a wet calibration, within the expected operating range, against a primary volumetric standard that is traceable to NIST.
7. Local display shall provide instantaneous flow rate information and totalized flow information and shall be factory configured for connection to a specific flowmeter.

D. Piping location for meter must meet the manufacturer’s recommendation for minimum specified length of straight pipe.

E. Refer to detail drawings for metering arrangement.

F. Meters shall record peak demand in tons and consumption in ton-hours times 10 or other appropriate factor corresponding to the daily consumption at each meter.

G. Demand meters shall be capable of transmitting a remote signal to the BMS.

H. Metering devices shall be calibrated to meter the specific system fluid being measured at the anticipated system temperatures.

I. Device mounting method shall allow for removal of device from a filled system without significant fluid loss.

J. All elements of the metering equipment exposed to fluid shall be rated for service at a minimum of 300 PSI and constructed of a stainless steel alloy compatible with fluid being measured.

K. Provide thermal wells and electronic temperature probes in supply and return piping to allow for a calculation of differential temperature in system being metered. Probes shall not be installed within the manufacturer's recommended minimum straight lengths of the flow meter.

L. Flow sensor shall be provided with electronic metering equipment to produce a signal proportional to flow that can be output to the BMS. Coordinate with control specification.

M. Measuring devices shall not require moving parts and shall sample across the full diameter of the pipe being measured.

N. Provide all tools and software required for proper operation and maintenance of metering equipment.

O. The mounting coupling shall be made of a material that is compatible with the process pipe material.

P. Electronic control module shall sample 20 times per seconds and convert collected data to a signal suitable for collection by the building management system. The building management system shall log data and maintain a running sum of daily, weekly, and monthly consumption.

Q. Basis of design shall use an electromagnetic meter. Notify owner and engineer of special conditions requiring the use of a strap-on type ultrasonic meter.

R. Provide BTU metering for the following systems:

1. Geothermal Water (Ground Loop)
2. Condenser Water (Building Loop)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturers recommendations. For clearance, upstream straight pipe length, downstream straight pipe length and support. Where manufacturers requirement for straight pipe is less than 15 pipe diameters (including up- and downstream straight lengths) a minimum of 15 pipe diameters shall be provided. Provide straightening vanes where required pipe lengths cannot be maintained.

B. Install meters and transmitters/displays adjacent to machines and equipment to allow service and maintenance. Displays shall be mounted at eye-level at the MER floor. Where this is infeasible, display shall be adjusted to proper angle for visibility from the MER floor.

C. Contractor shall connect all flow meter system elements, including sensors, meter transmitters, displays, etc.

D. Provide all labor and materials required to deliver a signal compatible with the BMS system. Contractor to connect, start-up and calibrate meter.

E. Entire system shall be covered by a 3-year parts and labor warranty.

END OF SECTION

SECTION 23 05 23

VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's product data including:

1. Dimensions
2. Sizes
3. End Connections
4. Weights
5. Installation instructions
6. Instructions on repacking and repairing valves.
7. Range of flow for balancing valves and plug valves.

B. Valve Tag List: See requirements in this Specification.

PART 2 - PRODUCTS

2.1 GENERAL

A. In addition to valves specified herein, provide products meeting the pressure requirements of the system.

B. Where type or body material is not indicated, provide valve with pressure class selected from MSS or ANSI standards, based on the maximum pressure and temperature in the piping system. Valve body material shall be coordinated with the piping system material.

C. Except for balancing or otherwise indicated, provide valve of same size as connecting pipe size.

D. All valves shall be ball or butterfly type. If globe, plug, or balancing valves are called out by note or symbol, only that type of valve is acceptable.

E. Ball valves or butterfly valves may be used in non-balancing applications when pressure and temperature ratings are adequate.

F. Where pipe sizes overlap, contractor has the option of threaded or flanged valves.

G. Where grooved pipe mechanical coupling systems are accepted, provide flange adapters to mate with valves as specified below. Valves manufactured by the mechanical coupling system manufacturer shall not be used unless they meet all of the specified requirements for a given valve and are of the same manufacturer as the adjoining couplings.

H. All valves shall be domestically manufactured unless approved for use by Engineer.

I. All components in hydronic systems shall be compatible with propylene glycol and water solution.

J. All valves shall be of a design which the manufacturer lists for the service and shall be of materials allowed by the latest edition of the ASME Code for pressure piping for the pressure and temperature contemplated, unless a higher grade or quality is herein specified.

K. Valve packing compression is to be independent of the stem, ball or handle systems. All valve stems are to be blowout proof. Packing shall be accessible without disturbing the insulation.

L. All valves used for vent or drain service on water systems shall have a brass hose connection with cap and chain.

M. Unless otherwise noted, all valves for shut-off and bypass service shall be ball valves, 2" and below, and butterfly valves 2-1/2" and above. Ball valves are acceptable in 2-1/2" and 3" copper only.

N. End connections for NPS 2" and below shall be the same as is used for fittings. Use flanged valves for NPS two and one half inches (2-1/2") and above. Solder joints are also acceptable in 2-1/2" and 3" copper piping systems.

O. Install valves after welding adjacent to valve is completed to protect seat and disk.

P. All valves used for vent or drain service on water systems shall have a brass hose connection with cap and chain.

Q. Non-electric radiator control valves with valve mounted heads are not acceptable, except on cast iron radiators, where they shall be side mounted. Where used, thermostatic radiator valves shall be remote bulb and remote control head design. The control head shall be mounted on the radiation enclosure, if possible.

R. Plug or gate valves shall not be used on any services without approval by the Vassar Department of Planning, Design and Construction.

2.2 GLOBE VALVES (Water, Oil, Gas)

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
   a. Viega
   b. Crane
   c. Nibco
   d. Powell
   e. Gruvlok
   f. Stockham

2" AND SMALLER	UNDER 300 PSI	Milwaukee Model 591A Bronze, 150 SWP at 406 deg. F., 300 WOG at 150 deg. F., Non-Shock, Heavy Duty Service, Special Hardened Stainless Steel Seat Ring and Disc, Union Bonnet, Gland Packed, Threaded Ends
2 ½" AND LARGER	UNDER 200 PSI	Milwaukee Model F-2981 Iron, 125 SWP, 200 WOG, Non-Shock, Solid Disc, Bolted Bonnet, Gland Packed, Flanged Ends
3" AND SMALLER (for use with copper tubing)	UNDER 300 PSI	Milwaukee Model 590T Bronze, 150 SWP, 300 WOG, Heavy Duty Service, Teflon Disc, Union Bonnet, Gland Packed

2.3 ANGLE VALVES

A. Manufacturers:

1. Design Basis: Milwaukee

2. Other Acceptable Manufacturers:
   a. Viega
   b. Crane
   c. Nibco
   d. Stockham
   e. Hammond
   f. Gruvlok

2" AND SMALLER	UNDER 300 PSI	Milwaukee Model 595T Bronze Body, 150 WSP, 300 WOG, Threaded, Union Bonnet, Angle Bronze Disc
2½ " AND LARGER	UNDER 300 PSI	Milwaukee Model 595T Bronze, 150 SWP, 300 WOG, Heavy Duty Service, Teflon Disc, Union Bonnet, Gland Packed.

2.4 REFRIGERANT VALVES

A. All refrigerant valves shall be silver brazed joint as follows:

1. Globe Valves – 1-1/8" O.D. and smaller: packless, Henry type 626; 1-3/8" O.D. and larger: packed, wing cap, Henry type 203.
2. Angle Valves – 1-1/8" O.D. and smaller: packless, Henry type 647 and 642; 1-3/8" O.D. and larger: packed, wing cap, Henry type 216.
3. Globe valves shall be of all bronze with composition disc, threaded or brazed joint ends as required by piping system in which they are installed.
4. All refrigerant valves shall be silver brazed joint as follows:
   a. Check Valves – 7/8" O.D. and smaller: brass, Henry type 116A; 1-1/8" O.D. and larger: bronze, Henry type 205.

2.5 SILENT/WAFER CHECK VALVES

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
   a. Viega
   b. Metra Flex
   c. Hammond
   d. GA Industries
   e. Nibco
   f. Tyco
   g. Victaulic (for Grooved Pipe Systems)
   h. Gruvlok
   i. Stockham

2½" – 6"	UNDER 200 PSI @ 150 °F	Milwaukee Model 1400 Cast Iron body, Bronze trim, Center guided single disc, 200 PSI rating.
8" -10"	UNDER 400 PSI @ 150 °F	Milwaukee Model 1400 Cast Iron body, Bronze trim, Center guided single disc, 400 PSI rating.

B. Hydronic piping system grooved end spring-loaded check valves shall be suitable for pressures up to 365 psi and operating temperatures up to 230 deg F.

1. 2” through 3”: Ductile iron body, stainless steel disc and spring, nickel-plated seat, 365 psi CWP.
2. 4” through 12”: Ductile iron body, EPDM coated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, 300 psi CWP.

C. Double disc or bi-folding disc type valves are not acceptable.

2.6 SWING CHECK VALVES

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers;
   a. Viega
   b. Crane
   c. Nibco
   d. Hammond
   e. Stockham
   f. Victaulic (for Grooved Pipe Systems)
   g. Gruvlok

2” and Smaller	Under 400 PSI	Milwaukee Model 508 Bronze body, 200 PSI SWP, 400 PSI WOG, Straight through pattern, bronze disc

B. Hydronic piping system grooved end horizontal swing check valves shall be suitable for pressures up to 300 psi and operating temperatures up to 230 deg F. Ductile iron body, type 316 stainless steel clapper, EPDM seat.

C. Two inches (2") and under: 45˚ swing check, screwed end.

D. Two and one half inches (2 1/2") and over: Non-slam type globe style lift check, non-slam type tilting disc or wafer body non-slam type lift check. Double disc or bi-folding disc type valves are not acceptable.

2.7 BUTTERFLY VALVES (Water, Oil, Gas)

A. Manufacturers:

1. Design Basis: Bray
2. Other Acceptable Manufacturers:
   a. Jamesbury
   b. Victaulic (for Grooved piping systems)

½” – 1 ½”	USE BALL VALVE	
2” – 8”	UNDER 250 PSI	Bray Model 40/41 Cast Iron body, Stainless Steel stem, 316 stainless steel disc

B. Butterfly valves in size 2" - 8" shall be of the single flange, lug body style. Bodies shall be ductile iron. Valves shall provide drip-tight shutoff at differentials up to 300 psi.

C. Lug body valves shall have a retained seat and shall provide tight shutoff up to the full valve rating on dead end or isolation service without the use of downstream flanges.

D. All valves shall be furnished with self lubricated bearings of TFE coated stainless steel. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.

E. Body:

1. Shall be one-piece wafer, lug or double flanged design with extended neck to allow for 2” of piping insulation.
2. Flange hole drilling per international flange standard as specified.
3. Provided with top and bottom stem bearings consisting of a 316 stainless steel shell with a TFE/glass fabric liner bearing surface.
4. Equipped with an externally adjustable stem packing system that allows packing adjustment without removing the actuator.
5. Internal over-travel stop shall be provided to prevent over-travel of the disc and minimize possible seat damage.

F. Seats:

1. Design shall consist of a resilient energizer totally encapsulated by the seat.
2. Seat retainer shall be full-faced and firmly attached by bolts located outside the sealing area to protect them from corrosion.
3. The seat assembly shall be locked in the body recess by the full-faced retainer.
4. The seat shall be self-adjusting for wear and temperature changes.
5. The seat shall be easily field replaceable.

G. Stem:

1. Shall be one-piece design
2. Stem shall be provided with blow-out proof stem retention system to assure full retention of the stem in the unlikely event of an internal stem failure.
3. Disc-to-stem connection shall be an internal connection design with no possible leak paths in the disc-to-stem connection. External disc-to-stem connections such as disc screws or pins are not allowed.
4. Stem shall be provided with blow-out proof stem retention system to assure full retention of the stem in the unlikely event of an internal stem failure.

H. Disc edge shall be hand polished for minimum torque and maximum sealing capability.

I. Valve shall be tested for tight shut-off per API 598 requirements.

J. Latch lock levers shall provide automatic, positive latching in the open, closed or eight intermediate positions. These valves shall allow locking in any position with a standard padlock. Infinite position levers shall allow manual throttling and locking in any position from open to close. External disc position indicators shall be provided.

K. All manually actuated valves 8" and larger shall be operated using a cast iron housed handwheel actuator available in standard, weatherproof, or buriable constructions - as required - with optional chainwheel, crank, or 2" square nut input. All units to have adjustable open and closed position stops with provision to prevent accidental adjustment changes. Operating shaft to be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings.

L. Butterfly valves equipped with gear or automatic operators shall have operator factory mounted and the stops factory adjusted. Loose gear operators shall not be permitted to be installed in the field. Gear operators on steam valves shall be spaced a minimum of 4” above packing assembly.

M. All automatic butterfly valves intended for exterior use shall be furnished with and wired for crankcase heaters.

N. Grooved end steel pipe butterfly valves 2" through 12" shall be ductile iron, nickel-plated ductile iron stainless steel disc, type 416 stainless steel two-piece stem, disc shall be offset from the stem centerline to provide continuous 360 degree seating, EPDM pressure-responsive seat and seal material suitable for water temperatures to +250 deg F. Valve shall have a lever handle or gear operator with handwheel. Valve shall be suitable for bubble tight shutoff, dead-end and bi-directional service at 300 psi full rated pressure. Victaulic Vic-300 MasterSeal or engineer approved equal.

O. Grooved end copper tube butterfly valves, 2-1/2" through 6", shall have copper-tube dimensioned bronze body, EPDM pressure responsive seat, aluminum-bronze disc, and stainless steel stem. (Stem shall be offset from the disc centerline to allow complete 360 degree circumferential seating.) Valves shall have lever handle or gear operator with handwheel and shall be suitable for bubble tight shutoff, dead-end and bi-directional service at 300 psi full rated pressure. Victaulic Series 608N or engineer approved equal.

2.8 BALL VALVES

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:

   a. Viega
   b. Apollo
   c. Dyna Quip
   d. Hammond
   e. Victaulic (for Grooved Pipe Systems)
   f. Watts
   g. Bray
   h. Gruvlok
   i. Stockham

3" and above	UNDER 300 PSI	Milwaukee BA400 Bronze body, Threaded, Full Port, SST Trim, Blowout-Proof Stem, 300 lb. WOG 150 PSI Non-Shock Cold Working Pressure, 150 PSI/Saturated Steam. Conforms to MSS SP-110 Reinforced Teflon seat
2½" and below	UNDER 300 PSI	Bronze body, standard port, 316 SST ball, 316 SST stem, Stem extension for insulated applications, RTFE seat, 15% glass filled double seal, Seat working rating 300 PSIG, 250°F minimum, Body working rating 300 PSIG 300°F minimum. 300 PSI WOG. 150 PSI steam

B. Options: Provide the following where required:

1. Extended stems for insulated valves.
2. Memory stop device for balancing applications.
3. Tee handle for tighter areas.
4. Hose end and cap for drain.
5. Mounting pads for actuator.
6. Provide "stop and drain" for compressed air.

C. Minimum flow coefficients (Cv):

Size	Cv
½"	8
¾"	14

1”	35
1¼”	46
1½”	75
2”	105
2½”	300
3”	390
4”	680

2.9 BALANCING VALVES

A. Manufacturer, variable orifice type circuit setter:

1. Viega
2. Armstrong
3. Victaulic/Tour and Andersson
4. Nibco
5. Oventrop

2” AND SMALLER	UNDER 300 PSI	Armstrong CBV-VS/VT Brass alloy body/stem and disk, 300 PSI Max. Working Pressure, -4°F to 300°F Operating Temperature Range, Threaded or Solder Connections Victaulic/Tour & Andersson Series 786, 787, 78K A metal brass copper alloy body, EPDM o-rings, 4-turn digital hand wheel for balancing, soldered or threaded end connections, 250°F temperature rating.
	UP TO 350 PSI	Oventrop Hydrocontrol R Bronze alloy body/ brass alloy stem and disk, 7-turn minimum veneer/digital hand wheel, threaded or solder end connections, 300°F rated operating temperature
2 ½” AND LARGER	UNDER 125 PSI	Armstrong CBV-FS/FA 125 PSI rating, Cast Iron valve body, Bronze disc, Brass stem, Stainless Steel spring, Straight or Angle
	UP TO 350 PSI	Victaulic/Tour & Andersson Series 789. Ductile iron body, EPDM o-rings, multiple-turn digital readout handwheel for balancing, flanged or grooved end connections, 250 deg F temperature rating. Oventrop Hydrocontrol G Cast iron body / brass alloy stem and disk, 8-turn minimum veneer/digital hand wheel, grooved end connections, 300°F rated operating temperature.

B. Manufacturers, valve and venturi type:

1. Flowset
2. Gerand
3. Griswold
4. HCI
5. Nexus
6. Oventrop

7. Preso

C. Connections: Threaded, soldered, grooved, or flanged.

D. Pressure Reading Ports:

1. "P/T" Ports, Shraeder valves, or Hansen type quick connect. No "refrigeration" fittings.

E. Design, variable orifice type:

1. Globe-type valve.
2. Multiple turns of handwheel from full closed to full open.
3. Bubble-tight shut-off.
4. Taps upstream and downstream.
5. Memory stop device to allow valve to be returned to balanced position after being closed.

F. Design, valve and venturi type:

1. Ball valve complying with the above requirements for ball valves.
2. Fixed orifice or venturi, upstream of valve.
3. Taps on venturi, upstream and downstream.
4. Memory stop device to allow valve to be returned to balanced position after being closed.
5. Regardless of the manufacturer's claims, these valves shall not be considered as tight shut off for service. Provide additional valves for equipment isolation.

G. Insulation: Provide premolded insulation conforming to the valve body. Material shall have a flame spread of 25 and a smoke development of 50.

H. Where application or building height causes working pressure to exceed 150 psi. Provide 2" and smaller: Crane No. 80E, 250 lb. WSP, bronze; 2 ½" and larger: use globe.

I. Balancing Cocks: Up to 2"

1. Bronze.
2. Screwed 120 psi WSP Class; similar to Fig. 554.
3. 250 psi WSP Class; similar to Fig. 576.

J. Balancing Cocks 2½ and 3"

1. Iron body similar to Walworth Co.
2. Screwed.
3. 120 psi WSP Class; similar to Fig. 651.
4. 250 psi WSP Class; similar to Fig. 671.

K. Balancing cocks 4" and above

1. Provide flanged lubricated plug valve.

L. Automatic Balancing Valves (1/2" through 1-1/2"):

1. Manufacturers:
   a. Hays
   b. Griswold
   c. Oventrop
   d. Balancing accuracy shall be within 10% of maximum flow.

e. Suitable for up to 600 psig. 32°F to 225°F operating temperature range.
f. Select cartridges based on maximum flows listed in equipment schedules. Valves shall provide automatic control over a 40 to 1 differential pressure operating range (2-80 psi). Differential pressure control cartridges shall be changeable after installation in case of flow rate change.
g. All valves shall have permanent label indicating model number, size, and flow.
h. Provide with pressure/temperature taps for verification of pressure drop.
i. Materials:
   1) Diaphragm: Elastomeric.
   2) Orifice: Brass or polyphenylsulfone.
j. The balancing valves shall be Y-pattern globe style design and all metal parts of nonferrous, pressure die cast, nonporous DZR Brass. Each valve shall provide four (4) functions:
   1) Precise flow measurement
   2) Precision flow balancing
   3) If used as equipment isolation, provide positive shut-off with no drip seat.
   4) If provided with strainer, provide drain connection using 3/4" NPT hose end thread. Otherwise drain connection shall be provided on strainer.

2.10 COMBINATION THROTTLING/CHECK/SHUTOFF VALVES

A. Manufacturers:

1. Basis of Design: Armstrong Flo-Trex Valve.
2. Other Acceptable Manufacturers:
   a. Bell and Gossett
   b. Taco
   c. Watts

B. Features:

1. 150 psi, 230ºF water working pressure.
2. Globe style valve with stainless steel spring loaded brass disk guided and limited by a brass or stainless steel stem.
3. Resilient seat.
4. Able to be re-packed under pressure.

C. Tri-Duty Valve Assembly: Combination shutoff, throttling, and non-slam check service in one unit, with pressure rating up to 300 psig at 230 deg F. Victaulic Vic-300 MasterSeal™ butterfly valve and Series 716H/716 check or 779 venturi check valve with flow measurement capabilities assembled with Victaulic couplings (style to be determined by system requirements). For sizes 14” through 24”, assembly shall consist of Vic-300 AGS butterfly valve and Series W715 dual disc design check valve with pressure rating up to 250 psig at 230 deg F.

2.11 SUCTION DIFFUSERS

A. Manufacturers:

1. Basis of Design: Armstrong
   a. Bell & Gossett
   b. Taco
   c. Victaulic (for grooved pipe systems)
   d. Watts

B. Features:

1. 150 psi, 230ºF water working temperature.
2. Strainer shall be 1/8” perforated stainless steel.
3. Provide a removable cover for easy access to the strainer.
4. Ductile iron body.

C. Pump suction diffuser with grooved inlet and straight, single, or double reduction flanged outlet, ASTM A395 ductile iron body, Type 304 stainless steel frame and perforated sheet diffuser with 5/32” diameter holes, Type 304 stainless steel 20-mesh startup pre-filter, pipe plug for system drainage, and bosses for support. Victaulic Series 731-D rated to the working pressure of the mating flange.

2.12 DRAIN VALVES

A. Ball valve with hose end adapter and cap. Milwaukee BA100H or approved equal.

B. Drain valves: 2” and smaller: Crane No. 451, 300 lb. WOG, non-rising stem, Hose end, bronze with bronze cap and chain.

C. Where application or building height cause working pressure to exceed 150 psi provide Crane No. 453, 300 lb. WOG, non-rising stem, hose for valves 2” and smaller.

2.13 PLUG VALVES

A. Manufacturers:

1. Design Basis: Homestead
2. Other Acceptable Manufacturers:
   a. DeZURIK
   b. Victaulic (For grooved pipe systems)

B. Model: Series 600 (ANSI class 125) cast-iron, full port body; EPDM coated plug; welded nickel seat; stainless steel bearings; integral memory stop device.

C. Lubricated Plug Valves:

1. Full port opening tapered plug suitable for lubrication under service pressure with plug in any direction.

2. Lubricating Guns:
   a. One for every 10 valves.
   b. Extra heavy, lever type, hydraulic hand gun.
   c. 15,000 psi gauge and 12" long connection hose.
   d. Similar to Walworth #1699 or approved equal.

3. Lubricant:
   a. Manufacturer's recommendations.
   b. One year supply, each valve.

4. Operators:
   a. 4" to 6", wrench, except as noted. Provide wrench set for each size valve, one wrench for every 10 valves, each size.
   b. 8" and larger: Gear operated with permanently installed handwheel.

5. Valve Construction

   a. Piping less than 100 psi: 200# WOG Class, cast iron body.
   b. Piping 100 psi to 250 psi: 500# WOG Class, cast iron body.

c. Piping over 250 psi: 720# WOG Class, carbon steel body.
d. Up to 2": screwed. 2½ " and larger: flanged, USAS 250#.
e. Similar to the following Walworth figure numbers:

Class	4"	5" & 6"
200#	1700F	1705F
500#	2720F	2721F
720#	1760F	1761F

6. In lieu of lubricated plug valves use DeZURIK BOS-US for piping up to 250 psi. For piping above 275 psi use DeZURIK BHP high performance butterfly valve.

D. Non-Lubricated, Eccentric Type Plug Valves:

1. 175 psi CWP, ductile iron body and plug, EPDM plug coating, welded-in nickel seat, grooved ends, lever handle or gear operator with hand wheel. Victaulic Series 377.

2.14 BUTTERFLY VALVE (WATER SERVICES)

A. Ductile or cast iron body.

B. Fully lugged 316 or 17-4 pH stainless steel trim.

C. Stainless steel disc.

D. Resilient seat fully bi-directional dead-endable EPDM seat. Working pressure 150 PSIG at 250 PSIG.

E. Body working pressure ANSI 150.

F. Handwheel gear operator above 4”, locking lever handle below 4”.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish all valves as indicated on the plans, and as may be required for the proper control of the pipe lines installed under this Specification, so that any fixture, line or piece of apparatus may be cut out for repair without interference or interruption of the service to the rest of the Building.

B. Install valves where required for proper operation of piping and equipment including valves in branch lines necessary to isolate sections of piping. Whether they are shown on the drawings or not, provide isolation valves at the following locations:

1. All branch piping connections to risers
2. All branch piping connections to piping mains
3. Branch piping at each mechanical room
4. Each piece of equipment, fixture, and appliance so that the supply and return services can be shut off to remove the item without draining the remainder of the piping system

C. Provide drain valves at main shut-off valves, all low points of piping and apparatus.

D. Install check and globe valves on downstream side of the shutoff valve on hot water circulating riser and branch lines.

E. Provide shut-off valves and check valves on each pump discharge line.

F. Locate all valves so as to be accessible.

G. All valves shall be installed as per manufacturer's recommendations.

H. Combination balancing and shut-off valves may be used instead of a separate balancing valve and shut-off valve if the valve has a memory stop and the manufacturer lists its use as a leak-proof service valve

I. Valves, where exposed and used in connection with finished piping, shall be same finish as the pipe.

J. Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.

K. Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves where corrosion is indicated or can be expected to occur.

L. Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

M. Select and install valves with renewable seats, except where otherwise indicated.

N. All valves shall have the trademark of the manufacturer and the guaranteed working pressure cast or stamped on the body of the valve.

O. Provide separate support for weight of valve where necessary.

P. Install all valves except butterfly with stems pointing up, and as close to vertical as possible. Butterfly valves to be offset at least 10° from vertical. Do not allow meter connections of balancing valves to point downward.

Q. Except as otherwise indicated, install ball, globe, and butterfly valves to comply with ANSI B31.1.

R. All valves of a given type shall be of one manufacturer.

S. Provide extended stems on insulated system to prevent interference of operator with insulation.

T. Provide chain wheel operators for valves more than 7' – 0" AFF in mechanical rooms and wherever shown on drawings.

U. Grooved end valves shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved end valves shall be the products of a single manufacturer. Grooved end shall be clean and free from indentations and projections. A factory-trained field representative shall provide on-site training for contractor's field personnel in the installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

V. Provide ball valves for shut-off on all pressure gauges at the gauge and separate 1/2" (one half inch) ball valves for the various taps to the gauge on a manifold gauge.

3.2 CHECK VALVE INSTALLATION

A. Swing and Check Valves:

1. Install only in horizontal lines unless absolutely impractical. If installed vertically, flow shall be upwards.
2. Do not install in pump discharge piping.

B. Silent Check Valves:

1. Install in all pump discharge lines.
2. Silent check valves may be installed in vertical pipes with flow down upon Engineer's review for each instance.

C. Installation of Check Valves:

1. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position.
2. Horizontal Lift Check Valve: Install in horizontal piping line with stem vertically upward.
3. Vertical Lift Check Valve: Install in vertical piping line with upward flow with stem vertically upward.
4. Air Compressor Lift Check Valve: Install in air compressor discharge line.
5. Spring Loaded Horizontal Lift Check Valve: Install in horizontal piping line with stem vertically upward.

3.3 VALVES USED FOR THROTTLING/BALANCING

A. Balancing valves shall not be used for flow indication in pipes 2½" and larger, or in pump discharge piping.

B. Flow indication in piping 2½" and larger and in pump discharge piping, shall be by a venturi with a plug, butterfly, or globe valve for throttling.

C. Throttling/Balancing Valves shall be selected so that the maximum design flow causes between 1' and 10' W.G. pressure drop or meter reading with the valve wide open.

D. Install balancing valves (excluding flow limiters) used for flow indication with a minimum of ten times pipe diameters downstream of a pump, five times the pipe diameter downstream and two times the pipe diameter upstream of a fitting or valve, unless otherwise specified by the valve manufacturer.

E. Circuit setters or plug valves may be used for throttling/balancing. Provide an infinitely variable, lockable memory stop device to allow the valve to be returned to the "balanced" position after closing, and to prevent movement of the disk or plug during operation. When ball valves are used for throttling, provide an additional valve for equipment isolation.

3.4 COMBINATION THROTTLING/CHECK VALVES

A. Combination throttling/check valves may be used in lieu of separate throttling and check valves on pump discharge piping. However, they may not be used for flow measurement.

END OF SECTION

SECTION 23 05 29

PIPE SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 STANDARDS

A. Comply with MSS Standard Practice SP-58, SP-69 and SP-89, published by Manufacturer's Standardization Society of the Valve and Fitting Industry for type and size.

1.2 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Hangers other than clevis type.
2. Anchors.

B. Submit structural calculations for trapeze type supports.

PART 2 – PRODUCTS

2.1 PIPE HANGERS

A. General:

1. Use adjustable pipe hangers on suspended pipe. Trapeze hangers may be used at the Contractor's option. Contractor shall be responsible for sizing supports.
2. Chain, wire or perforated strap hangers will not be permitted.
3. Isolate hangers in contact with dissimilar materials with dielectric hanger liners. Tape is not acceptable.
4. Provide supports between piping and building structure where necessary to prevent swaying.

B. Hanger Rods:

1. Exposed in public areas: Zinc electroplated steel.
2. Concealed or in service areas: Black threaded steel.
3. Outside, exposed to weather: Hot dipped galvanized.

C. Spot Concrete Inserts: Steel case and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

1. Size inserts to match size of threaded hanger rods.
2. Inserts to be UL and FM listed.
3. Minimum 1000 lb. Capacity with ½" rod.

D. Channel Type Inserts:

1. Standard channel support with anchor tabs on 4" centers, and nail holes for attaching to forms.
2. Styrofoam inserts to prevent wet concrete seepage.
3. Minimum 2000 pounds/foot capacity.

E. Expansion Anchors:

1. For use only in renovations or where modifications to piping layouts require installation away from pre-installed insert locations.
2. Inserts shall be of the drill, insert, and expand type. Power driven fasteners are not acceptable for piping.
3. Contractor shall select the appropriate type based on the following:

Rod Size	Maximum Working Load
3/8	600 pounds
½	1100 pounds
5/8	1800 pounds
¾	2700 pounds
7/8	3700 pounds

F. Steel Structure Attachments:

1. Contractor may select welded or mechanically attached. All mechanically attached supports shall have jam nuts or other means to prevent loosening. Maximum loading requirements are as follows:

Rod Size	Maximum Working Load
3/8	600 pounds
½	1100 pounds
5/8	1800 pounds
¾	2700 pounds
7/8	3700 pounds

G. Single Hangers:

1. Piping 2" and smaller: MSS type 1, Clevis hanger or type 7 adjustable swivel ring hanger. Minimum 180 pounds design load.
2. Piping 2" and smaller (steel): Clevis hanger, Anvil Fig. No. 260, F & M Fig. No. 239, Paterson Fig. No. 100.
3. Piping 2" and smaller (copper): Adjustable wrought iron, Anvil Fig. No. CT-65, F & M Fig. No. 364, Paterson Fig. No. 100 CT
4. Piping 2½" and larger: MSS type 1 Clevis hanger.
5. Piping 2½" to 4" (steel): Adjustable swivel pipe roll, Anvil Fig. No. 181, F & M Fig. No. 2729, Paterson Fig. No., 16.
6. Piping 2½" to 4" (copper): Adjustable wrought ring, Anvil Fig. No. CT-69.
7. Piping 5" and above: Two rod roller hanger, Anvil Fig. No. 171, F & M Fig. No. 170, Paterson Fig. No., 142.
8. Bare copper pipe: Above hangers, plastic or Neoprene coating, sized for copper pipe O.D. and copper coated for identification.
9. Insulated pipe: Hangers to be sized for O.D. of insulation. Hangers shall not penetrate any insulation.
10. Cast iron pipe above hangers sized for O.D. of cast iron pipe.
11. Hanger wire, cable or perforated metal strapping are not acceptable.

H. Trapeze hangers and wall supports:

1. Channel strut or structural steel shapes. Contractor shall follow channel strut manufacturers guidelines for loading or provide structural steel supports designed by a professional Engineer, licensed in the state where the project is located.
2. All piping shall be attached to the support by means of a channel strut clamp, U-bolt, or pipe rollers which will maintain lateral position of the pipe but allow longitudinal movement. Provide dielectric isolation between all dissimilar metals.
3. All insulation shall be continuous at supports. Do not notch or penetrate insulation or vapor barrier.
4. Kindorf or similar materials used for support of small piping shall not be used for piping 3" or larger.
5. ½" through 3": Unistrut type channel and steel clamp.
   a. Use Hydrosorb cushions on copper pipe.

6. 4" and Over: Welded steel bracket and wrought steel clamp.

I. Vertical Supports: Provide steel riser clamp at each floor penetration or every 14 foot supported from wall bracket. Do not anchor riser clamps.

J. Hangers:

1. General: Adjustable wrought steel clevis with locking nut attachment.
2. Multiple or Trapeze: Steel channels with welded spacers and hanger rods.
3. Hanger Sizes and Spacing:
   a. For drain piping, conform to the code requirements for spacing, and the following table for hanger rod sizes.
   b. For hydronic piping, conform to the following table:

PIPE TYPE	PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING	MINIMUM HANGER ROD SIZE
Steel and	½"	6'-0"	15'-0"	3/8"
Stainless Steel	¾" thru 1¼"	8'-0"	15'-0"	3/8"
Pipe	1½" and 2"	10'-0"	15'-0"	3/8"
	2½" thru 3½"	12'-0"	15'-0"	½"
	4" and 5"	12'-0"	15'-0"	5/8"
	6"	12'-0"	15'-0"	¾"
*	8" thru 12"	12'-0"	15'-0"	7/8"
Copper Pipe	½" thru 1"	8'-0"	10'-0"	3/8"
	1¼" thru 2"	10'-0"	10'-0"	3/8"
	2½" thru 3"	10'-0"	10'-0"	½"
	4"	10'-0"	10'-0"	5/8"
	6"	10"-0"	10'-0"	¾"
Copper Tubing	1¼ " and below	6'-0"	10'-0"	3/8"

* Submit routing and support plans to Architect/Engineer for review.

K. Insulated Pipe Supports:

1. Size pipe supports for outside diameter of pipe insulation.
2. It is not acceptable to notch insulation or vapor barrier at supports.

L. Pipes over five inches and over 120ºF: Provide cast iron roller supports.

M. Beam clamps - Hangers supported from floor steel shall be approved I beam clamps. I beam clamps for hangers supporting piping 2 inches and smaller shall be C & P Fig. No. 148 adjustable beam clamps. For piping 2-1/2 inches and larger, I beam clamps shall be wrought steel. C & P Fig. No. 268 or equal.

N. Hangers for copper piping shall be copper plated.

2.2 INSULATION INSERTS

A. Pipe shall be protected at the point of support by an insert of high density, foam glass insulation, encased in a sheet metal shield. Insert to be same thickness as adjoining pipe insulation. Insulation insert to extend one inch beyond sheet metal shield on all "cold" lines. If pipe hanger spacing exceeds ten feet and for all pipe roller applications, utilize double layer shield on bearing surface.

B. Provide 180º insulation inserts when utilizing clevis hangers. Provide 360º insulation inserts at all trapeze and wall supports.

2.3 PIPE ANCHORS

A. Manufacturers:

1. Design Basis: Flexonics
2. Other Acceptable Manufacturers:
   a. Adsco
   b. Keflex
   c. Hilti

B. Model AC with threaded ends and welded angle brackets for steel pipe.

C. Model AC copper tube with solder ends and steel angle brackets brazed to tubing for copper tube.

D. Anchors may be field fabricated similar to manufactured products specified.

2.4 PIPE GUIDES

A. Manufacturers:

1. Basis of Design: B-line.
2. Other Acceptable Manufacturers:
   a. Fee & Mason
   b. Anvil
   c. M-Co
   d. PHD

B. Any of the Following:

1. Spider Type: B3281-7.
2. Roller Type: 2 sets of roller son opposite sides of pipe.
3. Slide Type: B3893 with hold down lugs.
   a. Not for use with cold piping.
4. Light duty, 1½" and smaller copper: U bolt or channel strut clamp (B2417) allowing clearance from O.D. of pipe or insulation.

2.5 ROOF MOUNTED PIPING

A. Manufacturers:

1. Miro Industries, Inc.
2. Portable Pipe Hangers, Inc.
3. Approved Equivalent.

B. Where roofing is not being replaced piping on roof shall be supported by an engineered prefabricated portable pipe system specifically designed to be installed on the roof without roof penetrations, flashing or damage to the roofing material. The system shall consist of recycled rubber or plastic bases, hot dipped galvanized or stainless steel frame

with threaded rods and suitable pipe hangers and supports. The system shall be custom designed to fit the piping and conduits to be installed and the actual conditions of service.

C. Provide seismic restraints as required for seismic zone.

D. Piping on areas of roof being replaced shall be installed on pipe curbs bearing on roof structure and flashed into roofing material.

PART 3 – EXECUTION

3.1 INSTALLATION OF PIPE SUPPORTS

A. Adequately support piping from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging and pocketing.

1. Provide supports between piping and building structure where necessary to prevent swaying.
2. Do not support pipe from other pipe or equipment.

B. Install hangers to provide minimum ½" clear space between finished covering and adjacent work.

1. Place a hanger within one foot of each horizontal elbow.
2. Space hangers generally as called for in Table in Part 2, Products.

C. Use hangers, which are vertically adjustable 1-½" minimum after piping is erected.

D. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

1. Set inserts in position in advance of concrete work.
2. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
3. Do not penetrate concrete "TT" legs for piping inserts. Do not penetrate the stressed (i.e. lower) chords of any structural member.

E. Provisions for Movement: Install hangers and supports:

1. To allow controlled movement of piping systems.
2. To permit proper movement between pipe anchors.
3. To facilitate the action of expansion joints, expansion loops, bends and offsets.
4. To isolate force due to weight or expansion from equipment connections.

F. In general, attach hangers to upper chord of roof trusses and floor joists, using long rods to facilitate pipe movement.

G. Anchors:

1. Use no pipe anchors. Arrange piping such that pipe expansion and contraction is accommodated by controlled movement of the pipe within the pipe supports. Provide sufficient offsets in branch piping to accommodate movement of main piping due to expansion and contraction. Where this is not possible due to building geometry or other reasons, securely anchor piping where indicated or where required for a proper installation and to force the pipe expansion in the proper direction.
2. Anchors shall be suitable for the location of installation and shall be designed to withstand not less than five times the anchor load.
3. Anchor vertical pipes by means of clamps welded around pipes and secured to wall or floor construction. Anchor at bottom of riser only but provide guides for vertical thermal movement.
4. All anchors shall be separate and independent of all hangers, guides, and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work approved by the Architect. Anchors shall be welded to the pipe and fastened to the structure with bolts.

5. Anchors shall be fabricated and assembled in such a form as to secure the piping in a fixed position. They shall permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points: and shall be so arranged as to be structurally suitable for particular location, and line loading. Submit details for approval.

H. Assume the responsibility for the proper transfer of the loads to the piping systems to the structure. No additional cost to the owner should be expected for any corrective work during construction.

I. Provide necessary structural members, hangers, and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc., are supported from metal decking and/or concrete construction, care shall be taken not to weaken decking and/or concrete or penetrate waterproofing. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted, both in the vertical and horizontal direction, when the supported piping is hot, or chilled, as required.

J. Provide supplemental bolted steel in all locations where drilling of slab will create unacceptable noise in adjacent spaces.

K. Where piping is run near the floor and not hung from the ceiling construction but is supported from the floor, such supports shall be of pipe standards with base flange and adjustable top yoke similar to C & P Fig. 247 or equal.

L. All vertical piping shall be anchored by means of heavy steel clamps securely bolted or welded to the piping, and with end extension bearing on the building.

M. Vertical runs of pipe not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs.

N. Vertical runs of pipe over 15 feet long but not over 60 feet long and not over 6 inches in size, or not over 30 feet long and not over 12 inches in size, shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and shall reset securely on the building structure without blocking. Clamps shall be welded to the pipes or placed below couplings. Clamps shall be type 8, Federal Specification WW-H-171C, unless other types are approved.

O. For all hydronic water and makeup water and insulated refrigerant piping, provide "Insulshield" as made by Insulcoustic Corp. or pipe covering protection shield F & S Fig. 980 with steel shield, with vapor barrier jacket. For hot fuel oil and hot-water heating piping 2 inches and smaller, same as above.

P. Piping in trenches shall hang from angle iron cross supports provided by the Contractor with two coatings of red led primer and final coat of black asphaltum paint.

Q. Hanger rods shall be attached to preset concrete inserts with steel reinforcing rod through the insert and both ends hooked over the reinforcing mesh. For pipes 4 inches and larger, rods shall extend through concrete slab above where they shall be attached to steel bearing plates 6" x 6" x 1/4".

R. Piping shall not be hung from other piping, ducts, conduits or from equipment of other trades and no vertical expansion shields will be permitted. Hanger rods shall not pierce ducts.

S. All water piping connected to rotating equipment within all mechanical spaces shall be isolated from the building structure by means of vibration hangers inserted in the hanger rods. The vibration hangers shall consist of a steel spring in combination with a double deflection neoprene element within a rectangular steel housing. Combined static deflection shall be 1.375" minimum. Hangers shall have capability of supporting the piping at a fixed elevation during installation and shall incorporate an adjusting device to transfer the load to the spring. Deflection shall be indicated by means of scale. Vibration hangers shall be type PCDNHS made by Mason Industries.

T. All piping running on walls shall be supported by means of hanger suspended from heavy angle iron wall brackets. No wall hooks will be permitted.

END OF SECTION

SECTION 23 05 30

ELECTRONIC SPEED CONTROLLERS

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data for each unit. Include:

1. Capacity:
   a. Horsepower
   b. Voltage
   c. Amps – both input and output
2. Wiring Diagrams:
   a. Include diagrams for basic unit and for all required accessories.
   b. Provide control wiring connections
3. Dimensions.
4. Installation instructions.
5. Description of diagnostic system.
6. Options provided.
7. BIM objects containing IFC parameters and associated data applicable to building system requirements.
8. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
   a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance, no exceptions.
   b. Notwithstanding the calculations specified above, provide harmonic filters on all drives with an input current rating higher than 78 amps.
9. Vendor shall program one drive of each type (pump, fan, etc.) and submit a complete listing of parameters to engineer for review with commissioning authority before proceeding with programming of all drives. Provide a complete listing of all parameters for each drive as both a hard copy and electronically in both text format and the format of the manufacturer's communication/service program.
10. The VFD manufacturer shall submit a list of all parameters with a suggested setting for each drive's specific application.
11. The VFD manufacturer shall submit documentation that the drive is capable of continuous operation at a minimum of 110% of motor nameplate rating, including the service factor.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
2. Underwriters laboratories UL508C
3. National Electrical Manufacturer's Association (NEMA) ICS 7.0, AC Adjustable Speed Drives
4. IEC 16800 Parts 1 and 2
5. National Electric Code (NEC) NEC 430.120, Adjustable-Speed Drive Sys
6. International Building Code (IBC)
   a. IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturer:

1. Basis of Design:
   a. ABB ACH 550
2. Other Acceptable Manufacturers (provided the submitted model adheres to the spec.):
   a. Allen Bradley 700 Series
   b. Eaton SPX 9000
   c. Hitachi SJ700

B. Drive shall convert the constant frequency AC line voltage to a variable frequency, variable voltage AC output suitable for control of a standard NEMA design B induction motor over a 10:1 speed range and with full load amp rating between 65% and 130% of the drive full load current capability and without modification to the motor or the drive.

C. Variable frequency drives for all three phase motors shall have the following features:

1. Drive input: 208 or 480 volts +30% to -35%, 3 phase, 60 Hz.
2. Drive output: 0-208 or 0-460 volts, 3 phase, 0-80 Hz. For efficient operation of a variable torque load.
3. Operating conditions: Capable of continuous operation at 0 to 50^0 C (-10 to 122^0 F) ambient temperature
   a. Provide conformal coating on all printed circuit boards
4. Drive type: Pulse width modulation type, designed to minimize harmonic generated noise in the motor.
5. Enclosure type: UL type as required for location.
   a. Drives shall be UL listed as a plenum rated VFD
   b. See additional enclosure requirements herein.
6. AC line circuit breaker.
7. Input fuses for the VFD which shall ensure operation of the bypass in the event of the short circuit of the VFD
8. The input current rating of the VFD shall be no more than 3% greater than the output current rating.
9. Provide VFD one horsepower size higher than motor size for drives where input current rating of the VFD is more than 3% greater than the output current rating.
10. Coordinate additional costs with contractor, ensure no additional cost to engineer and/or owner.
11. Metal oxide varistors on incoming line for transient protection.
12. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
13. The VFD and Bypass shall be rated 100,000 SCCR for short circuit interrupt.
    a. The installation fuses is not an acceptable design for SCCR rating.
14. 120 volt Control power transformer with fused primary and fused secondary.
    a. Control power shall be fed from the DC bus.
    b. Control contactors shall be 120V; 24 V are not acceptable.
15. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
    a. Start-up assistant
    b. Parameter assistants
       1) PID assistant
       2) Reference assistant
       3) I/O assistant
       4) Serial communications assistant
       5) Option module assistant
       6) Panel display assistant
       7) Low noise set-up assistant
    c. Maintenance assistant

d. Troubleshooting assistant
e. Drive optimizer assistants
f. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
   Output Frequency
   Motor Speed (RPM, %, or Engineering units)
   Motor Current
   Motor Torque
   Motor Power (kW)
   DC Bus Voltage
   Output Voltage

16. Instantaneous overcurrent shutdown with indicator light when current exceeds 200%. Time-overcurrent overload protection for the motor.
17. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays.
18. Inverse characteristic time-overcurrent overload protection for the motor sized in accordance with NEC requirements.
19. Drive shall be capable of withstanding random application of an output short circuit without damage to drive components or fuses.
20. Input phase loss and undervoltage protection.
21. Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload, or slow the acceleration ramp when accelerating a high inertia load.
22. Drives shall be capable of “riding through” a momentary loss of power for up to 2 seconds.
23. Provide AC line reactors in the drive cabinet for each VFD with an input current rating above 78 Amps for protection against line notching and surges without requirement for an input isolation transformer. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD’s with only one DC reactor shall add an AC line reactor.
24. There shall be no VFD components shipped loose and / or mounted external to the VFD cabinet
25. Power factor shall be minimum 95% at all speeds and loads.
26. UL listed
27. Minimum and maximum speed adjustment.
28. Factory Tests: The VFD shall be tested with the system logic and given complete factory tests including simulated operation.
    a. Provide certification this test has been made for the particular units shipped for this job.
29. Field Adjustments: Independent acceleration/deceleration rates: 0.5 – 120 seconds.
30. Provide a maximum of 1000 volts at the motor terminals.
31. PWM technology, with diode bridge front ends and IGB transistors (IGBT) in the output section that utilize soft switching.

D. Control Interface Components

1. Provide every VFD complete with all control devices to accomplish each function described in the specification. Field installation of sensors, relays, terminal strips, etc. is not permitted. Provide all transducers, relays and interface devices factory installed and wired to a dedicated terminal strip to provide the following functions (described elsewhere in the specification) as follows:
   a. Proof of flow – current sensing
   b. Damper control
   c. Smoke control – all modes as described herein
   d. Broken belt
   e. Single phase protection

f. Welded contactor
g. Amps – all phases
h. Volts – all phases

E. Serial Communications – addressable for drive and separately for the bypass

1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. [Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.
2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing – Read Property – B.
   b. Data Sharing – Write Property – B.
   c. Device Management – Dynamic Device Binding (Who-Is; I-Am).
   d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
   e. Device Management – Communication Control – B.
3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
6. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass' digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass' digital inputs shall be capable of being monitored by the DDC system. This allows for remote monitoring of which (of up to 4) safeties are open.
7. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.

F. Harmonic Filter - provide integral harmonic filters as part of the factory assembled VFD package, completely wired including interface of all monitoring and control points to the VFD serial communications. The integral harmonic filter shall be provided as follows:

1. The harmonic filter shall be designed to filter all characteristic low frequency harmonics (5th, 7th, 11th, 13th, etc.) .
2. The filter shall consist of inductive element(s) in series with the load and an inductive-capacitive network in shunt with the load. The shunt circuit shall be tuned to 4.7 times the fundamental frequency.
3. The filter shunt circuit shall be protected by field replaceable fuses on each phase to ensure the VFD remains operational in the event of a capacitor over current or other condition causing the fuses to open. Fuses internal to the capacitor cell shall not be acceptable in lieu of field replaceable fuses.
4. The filter shall have a fuse status which is monitored by a digital input on the VFD and available to the serial communications interface.
5. The filter shall have a labeled SCCR rating of 100kA per UL 508A. An SCCR rating of EXEMPT will not be accepted as a valid alternative.
6. The Total Demand Distortion (TDD) of the current at the input terminals of the filter, in combination with the variable frequency drive, shall not exceed 5% THID at full rated load and given the filter is correctly applied.
7. The Total Harmonic Voltage Distortion (THVD) at the input terminals of the filter in combination with the variable frequency drive shall not exceed the limits defined in Table 10-2 of IEEE-519.
8. The full load efficiency of the filter shall not be less than 97% for filters larger than 5 HP or less than 98.5% for filters larger than 25 HP. The voltage regulation at the VFD terminals and attributable to the filter shall not exceed 5%. Filters with greater than 10% voltage drop, and/or filters that have capacitors in series with the VFD, are not acceptable.
9. The filter shall have a shunt capacitor in the circuit to control the capacitive VARS on the power system. The contactor shall be controlled by a digital output on the VFD. Both shunt circuit inductors and series line reactors shall be designed for harmonic filtering service and for slowing the rate of rapid current changes.
10. The inductors shall be UL component-recognized or listed and shall be built to comply to UL 508. Construction shall be of copper wire-wound on magnetic steel cores. Inductors shall be three-phase. Series line reactors shall be sized appropriately for the total connected load. Design maximum temperature rise for inductors shall be 115°C on bobbin wound and 155°C on form wound devices at rated current. Windings shall consist of copper wire or of copper foil. Terminations shall be copper alloy ring lugs, UL-recognized terminal blocks, or solid copper bus. Completed inductors shall be impregnated, using 100% solid epoxy resin. All insulation varnish systems shall be rated class H (180°C) or class R (220°C), 600V. Inductors shall be Hi-Pot tested (2,500V, 60 Hz, 1 minute) line-to-line and line-to-ground.

G. Bypass Controller - All variable frequency drives shall be equipped complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.

1. Drives with an INPUT Amp Rating equal to 114 Amps or greater must include a solid state soft starter in the bypass circuit. The soft starter must include a shunt contactor which will close when the motor reaches full speed.
2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.
3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
4. The drive and bypass package shall be seismic certified and labeled to the IBC:
   a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.
6. The bypass shall include a minimum of two contactor (motor and bypass) and a lockable service switch to isolate the drive while in bypass mode. Designs that use a third contactor for drive isolation must also provide a lockable disconnect in series with the drive contactor for positive means of isolation avoiding the possibility of the drive contactor being welded closed.

7. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
8. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
9. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
    a. All current sensing transducers to accomplish single phase detection must be factory mounted. Faults for single phase must be displayed on the keypad and communicated over serial interface.
10. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
11. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.
12. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad "Hand" or "Auto" selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
13. The bypass serial communications shall allow control of the bypass' digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass' digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass' digital inputs shall be capable of being monitored by the DDC system.
14. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.
15. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
16. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override / smoke control mode.
17. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.

18. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
19. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
    a. Over current
    b. Over voltage
    c. Under voltage
    d. Loss of analog input
    e. The following operators shall be provided:
        1) Bypass Hand-Off-Auto
        2) Drive mode selector
        3) Bypass mode selector
        4) Bypass fault reset
20. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:
    a. Energy savings – in US dollars
    b. Bypass motor amps
    c. Bypass input voltage– average and individual phase voltage
    d. Bypass power (kW)
    e. Bypass faults and fault logs
    f. Bypass warnings
    g. Bypass operating time (resettable)
    h. Bypass energy (kilowatt hours – resettable)
    i. I/O status
    j. Parameter settings / programming
    k. Printed circuit board temperature
21. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
    a. Power-on (Ready)
    b. Run enable
    c. Drive mode selected
    d. Bypass mode selected
    e. Drive running
    f. Bypass running
    g. Drive fault
    h. Bypass fault
    i. Bypass H-O-A mode
    j. Automatic transfer to bypass selected
    k. Safety open
    l. Damper opening
    m. Damper end-switch made
22. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS / DDC system even with the VFD removed.
23. The on-board Form-C relay outputs in the bypass shall programmable for any of the following indications.
    a. System started
    b. System running
    c. Bypass override enabled
    d. Drive fault
    e. Bypass fault
    f. Bypass H-O-A position

g. Motor proof-of-flow (broken belt)
h. Overload
i. Bypass selected
j. Bypass run
k. System started (damper opening)
l. Bypass alarm
m. Over temperature

24. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
25. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.
26. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
27. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
28. Stair Pressurization Mode – the bypass shall include an option to control the speed of the motor based on an external pressure transmitter. In this mode the VFD shall modulate the speed of the motor to maintain a pressure setpoint and avoid over pressurization of the stairwell.
29. Preset speed mode – the bypass shall include an option to run the drive at a preset speed and follow the acceleration values programmed in the VFD. The preset speed can be any fixed value.
30. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.
31. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

H. In addition to the above feature all drives shall have the following additional features:

1. Catch-a-spinning load capability.
2. Critical speed avoidance capability.
3. Where the building walls are not suitable for mounting drives a floor stand kit shall be provided.
4. Provide output isolator to provide VFD signal operation of frequency, and current to an isolated 4-20 mA signal for transmission to the building automation system for monitoring capability.

I. For variable frequency drives serving multiple motors, the following shall be provided:

1. Provide redundant drives, each drive sized for the aggregated load of all motors.
2. The system shall monitor drive performance and switch to the standby drive in the event of a drive failure.
3. The system shall balance run time between drives
4. Manual switchover will be required in an instance of electrical system deficiencies such as under voltage, ground fault, single phase input, etc.

5. Provide motor contactors for each motor for drives serving more than one motor, each contactor shall have auxiliary contacts to prevent drive damage if remote motor disconnect switch is open of closed.
6. Each drive shall have contactors for each motor it serves with individual thermal overload protection for each motor and H-O-A motor select switch.
7. All multiple motor variable speed controllers shall be capable of operating even if one of the motors is off.
8. Multiple motor protectors must be integral to the VFD enclosure.

J. Enclosure: NEMA Type as required for location.

1. Provide NEMA 4X stainless steel enclosures in wash down areas, kitchens, dishwasher areas, exterior spaces, and any other areas designated by the Engineer. Provide space heater/air conditioning as well as all necessary conditioning within the enclosure as required to maintain the minimum internal temperature required by the manufacturer. Air conditioning shall be powered by a single point of connection within the cabinet.
2. Provide NEMA 3r enclosures for drives exposed to weather. NEMA 3 r enclosures shall be fabricated from 304 SS with protected keypads. The enclosure shall be bottom entry and shall include heating and ventilation to maintain and operation environment during design conditions
3. Provide NEMA 12 enclosure for all interior drives. NEMA 12 enclosures shall be fabricated from epoxy painted carbon steel with protected keypads. The enclosure shall be bottom entry.

K. For drive manufacturers who use portable test meter for diagnostics, provide not less than one test meter for each model or type used. Meters shall be supplied to the Owner upon completion of the project.

L. Provide one complete set of spare fuses for all variable speed controllers.

M. Interlock all disconnects with variable speed drive so variable speed drive opens before disconnect opens to prevent damage to the drive.

PART 3 – EXECUTION

3.1 Deliver units to installer of electrical work. Provide installation and wiring instruction and diagrams.

3.2 Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer. The local service office shall be staffed by factory trained engeers within a 100-mile radius of the job site. Training shall be provided for the Owner's service personnel at the Owner's facility.

3.3 Provide wiring control diagrams and instructions to installer of automatic temperature controls.

3.4 Provide Two years warranty to cover parts and labor

3.5 In applications where the drive will be more than 100 cable feet from the motor, it is the responsibility of the contractor to have the manufacturer coordinated with the motor manufacturer to ensure that the motor is suitable for the application, or to provide a motor protecting DV/DT filter on the drive output to protect the motor. The manufacturer shall adjust the carrier frequency to minimize the audible noise of the connected motor.

3.6 An asbult drive control schematic (ladder diagram) shall be taped to the inside of the drive cabinet and sent to the Project Engineer and be included as part of the closeout document package.

END OF SECTION

SECTION 23 05 48

VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract, and Specification Sections (General Requirements), apply to this Section.

1.2 DESCRIPTION

A. Furnish and install all vibration control devices, accessories, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.3 MATERIAL AND EQUIPMENT

A. Design Basis: Mason Industries

B. Alternate Manufacturers:

1. Vibration Eliminator Co.
2. Korfund Dynamics Corp.
3. Amber/Booth Co.
4. Vibration Mountings & Controls, Inc.

C. Unless otherwise specified, supply only new equipment, parts and materials.

1.4 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of this equipment with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than ten (10) years.

B. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

C. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.

D. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim or additional payment.

E. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

F. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.5 SUBMITTALS

A. Prior to ordering any products, submit shop drawings and the items listed below. The shop drawings must be complete when submitted and must be presented in a clear, easily understood form. Incomplete or unclear

presentation of shop drawings may be reason for rejection of the submittal. Contractor shall provide:

1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
   a. The equipment identification mark;
   b. A cut sheet of the isolated equipment showing equipment support points and operating weight at each point.
   c. The isolator type;
   d. The actual load;
   e. The static deflection expected under the actual load;
   f. Specified minimum static deflection;
   g. The additional deflection-to-solid under load;
   h. The ratio of spring height under load to spring diameter.
3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Special details necessary to convey complete understanding of the work to be performed.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

A. General:

1. All mechanical equipment shall be mounted in accordance with the specifications below and for the specific requirements shown in the equipment schedule.
2. The isolation manufacturer shall supply all unit isolators, complete rails, fan and motor bases and structural steel forms for concrete inertia blocks, where called for and shall be responsible for the selection of all vibration eliminators and shall guarantee to meet the requirements of these Specifications.
3. Wherever rotational speed is mentioned as the disturbing frequency, the lowest speed in the system shall be used. All isolation devices shall be selected for uniform static deflections according to distribution of weight. Lateral motion of all isolators shall be 1/4" maximum during start-up and shut-down.
4. All metal parts of vibration isolation units installed out-of-doors shall be cold-dip galvanized, cadmium plated, or neoprene coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14. Isolators shall be equipped with limit stops to resist wind velocity.
5. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
6. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
7. Static deflection of isolators shall be as provided in SECTION 3 - EXECUTION. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.
8. All fan units and air handling units (except fans with wheels under 27") shall be isolated as follows:

1.	Up to 450 RPM:	75% eff. (3-1/2" max. deflection)
2.	450 RPM to 850 RPM:	90%
3.	850 RPM and over:	95%

   Submittals shall show disturbing frequency, required efficiency, designed deflection and outside diameter of springs, when pertinent.
9. All horizontal pipe connected to rotating equipment within the mechanical equipment room area, but not less than 50 feet from connected equipment shall be isolated from building structure by means of units designed

for insertion in rods.

B. Type FSN (Floor Spring and Neoprene)

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one (1). All mounts shall have leveling bolts.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
3. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
4. If the isolator is to be fastened to the building structure and Type NP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.

   Type FSN isolators shall be Mason Type SLF with the appropriate neoprene pad (if used) selected from Type NP or approved equal.

C. Type FSNTL (Floor Spring and Neoprene Travel Limited)

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall not be less than 0.8 of the compressed height of the spring at the rate load. Spring shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one (1). All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of ¼" shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The NP isolator, separator plate, and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
3. If the isolator is to be fastened to the building structure and Type NP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.

   Type FSNTL isolators shall be Mason Type SLR with the appropriate neoprene pad (if used) selected from Type NP or approved equal.

D. Type FN (Floor Neoprene)

1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided

in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

Type FN isolators shall be Mason Type ND or approved equal.

E. Type FNC (Floor Neoprene Chiller)

1. Neoprene isolators shall be double neoprene-in-shear type with steel reinforced top intermediate plates and base. Neoprene elements shall be ¾". Steel plates shall be ¼" and the top and bottom plates shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

Type FNC isolators shall be Mason Type ND: Fabricate of type "Super W" pads, similar to Type ND otherwise.

F. Type NP (Neoprene Pad)

1. Neoprene pad isolators shall be one layer of ¼" to 3/8" thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.

Type NP isolators shall be Mason Type W or approved equal.

G. Type DNP (Double Neoprene Pad)

1. Neoprene pad isolators shall be formed by two layers of ¼" to 3/8" thick ribbed or waffled neoprene, separated by a galvanized steel, stainless steel or aluminum plate. If the isolator is outdoors, the plate shall not be made of galvanized steel. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.

Type DNP isolators shall be Mason Type WSW or approved equal.

H. Type HSN (Hanger Spring and Neoprene)

1. Vibration isolation hangers shall consist of a free standing and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc before contacting the housing. Hangers shall provide a means to adjust hanger elevation under load. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. The neoprene element shall be designed to have a 0.3" minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.

Type HSN isolators shall be Mason Type P30N or approved equal.

I. Type DSN (Double deflection spring and neoprene)

1. Vibration hangers shall contain a steel spring and a double deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection and be seated in a neoprene cup with an integral molded bushing that passes through the lower hanger box.

Type DSN isolators shall be Mason type DNHS or approved equal.

J. Type HN (Hanger Neoprene)

1. Vibration isolation hangers shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30º arc before contacting the hanger housing.

   Type HN isolators shall be Mason Type HD or approved equal.

2.2 EQUIPMENT BASES

A. Type BIB (Base - Inertia Base)

1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 lbs./cu.ft.) and appropriate steel reinforcing cast between welded or bolted perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, racks deform, deflect, or crack in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 the longest dimension of the inertia base, but not less than 6" nor more than 12". The base foot print shall be large enough to provide stability for supported equipment. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
2. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete may be provided by the General Contractors.

   Frame and reinforcement for Type BIB bases shall be Mason Type KSL or approved equal.

B. Type BC-1 (Base - Curb)

1. Curb type isolation bases shall be a prefabricated assembly consisting of an extruded aluminum frame and steel spring isolation system that fits over the roof curb and under the isolated equipment. The aluminum frame shall be sufficiently rigid to support the equipment load without detrimental twist or deflection. Spring isolators shall be selected and positioned along the curb to achieve the minimum static deflection called for in the schedule. The static deflection shall be constant around the entire periphery of the base. Springs shall be free standing, laterally stable with a diameter of not less than 0.8 times the compressed height, and have additional travel-to-solid that is at least 50% of the rated deflection. Resilient neoprene snubbers shall be provided at the corners of the base to limit the movement of the equipment under wind load to ¼".
2. The isolation curb base shall be made weather tight by sealing all around the periphery with closed cell neoprene or flexible vinyl. This shall in no way inhibit the vibration isolation of the spring elements. A closed cell sponge gasket or field caulking shall be used between the equipment unit and the isolation curb base and between the isolation curb and roof curb to form a weather-tight seal. The isolation curb shall be designed to arrest and utilize outer placement of standard 2" roof insulation to act as a sound attenuation for inside of the curb.
3. Each spring isolator used in the curbs shall be weather protected. The entire assembly shall be dry galvanized or PUC coated.

   Type BC-1 vibration isolation curb bases shall be Mason Type CMAB or approved equal.

2.3 RESILIENT LATERAL GUIDES

A. These units shall either be a standard product of the vibration isolation mounting manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements similar to Type FN which are specifically designed to provide resilient lateral bracing of duct or pipe risers.

Resilient lateral guides shall be Mason Type ADA.

2.4 FLEXIBLE DUCT CONNECTORS

A. Flexible duct connection shall be made from coated fabric (or leaded vinyl if called for on the drawings). The clear space between connected parts shall be a minimum of 3" and the connection shall have 5" minimum of slack material.

2.5 FLEXIBLE PIPE CONNECTIONS

A. Flexible pipe connection shall be fabricated of multiple plies of nylon cord, fabric, and neoprene; and shall be vulcanized so as to become inseparable and homogeneous. Flexible connections shall be formed in a double sphere shape, and shall be able to accept compressive, elongative, transverse, and angular movements.

B. The flexible connections shall be selected and specially fitted, if necessary, to suite the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected which do not require rods or cables to control extension of the connector.

C. Connectors for pipe sizes 2" or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

D. Provide Mason Industries Type MFTNC or MFTFU; Metraflex Twin Sphere; or Amber/Booth Type 2600 or 2655 for flexible pipe connections less than 220˚F and 150 psi.

E. Flexible pipe connections shall be mason Industries Type BSS braided stainless steel hose with carbon steel fittings for pressures above 150 psi or temperatures greater than 220˚F

2.6 RESTRAINTS

A. Snubber:

1. Snubbers shall be custom fabricated using Type FN isolators mounted to steel angle brackets. The steel angle shall be sufficiently rigid and the mounting sufficiently secure to resist excessive movement of equipment during on-off cycle.

B. Thrust Restraints:

1. Thrust restraints shall consist of a spring element in series with a neoprene pad. The unit shall be designed to have the same deflection due to thrust-generated loads as specified for the isolators supporting the equipment. The spring element shall be contained within a steel frame and be designed so it can be precompressed at the factory to allow for a maximum of ¼" movement during starting or stopping of the equipment. Allowable movement shall be field-adjustable.
2. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor.
3. Thrust restraints shall be Mason Industries Type WB, Kinetics Noise Control Type HSR, Amber/Booth Type TRK or an equal product of the manufacturer supplying the isolators.

2.7 GROMMETS

A. Grommets shall either be custom made by combining a neoprene washer and sleeve, be Isogrommets as manufactured by MBIS, Inc. (Bedford Heights, Ohio), or be Series W by Barry Controls (Watertown, Mass.). Grommets shall be sized so that they will be loaded within the manufacturer's recommended load range. Grommets shall be specially formed to prevent both from directly contacting the isolator base plate.

2.8 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes as described in this specification shall be silicone or one of the non-setting sealants indicated below:

Acoustical Sealant	D.A.P
BR-96	Pecora
Acoustical Sealant	Tremco
Acoustical Sealant	U.S.G.

PART 3 - EXECUTION

3.1 APPLICATION

A. General:

1. Refer to SECTION 2 - PRODUCTS of this specification for vibration isolation devices identified on the drawings or specified herein.
2. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.
3. Refer to Section 23 05 49 for seismic requirements.

B. Major Equipment:

1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4” high concrete housekeeping pads. Mount vibration isolating devices and related inertia blocks on concrete pads.
2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as scheduled on the drawings or specified hereunder.
3. Flexible duct connections shall be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the drawings.
4. Flexible pipe connections shall be installed at all pipe connections to vibration-isolated equipment, refer to drawings for proper position.
5. Thrust restraints shall be installed on all floor-mounted fans developing 4” or more of static pressure, all suspended fans developing 2” or more static pressure, and wherever else called for on the drawings.
6. Snubbers shall be installed as called for on the drawings.
7. Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolator manufacturer.

C. Miscellaneous Mechanical Equipment:

1. Miscellaneous pieces of mechanical equipment such as converters, pressure reducing stations, dryers, strainers, storage tanks, condensate receiver tanks, and expansion tanks which are connected to isolated piping system shall be vibration isolated from the building structure by Type NP or Type HN isolators (selected for 0.1” static deflection) unless their position in the piping system requires a higher degree of isolation as called for under Pipe Isolation.

D. Pipes:

1. All geothermal water, drain and engine exhaust piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:
   a. Within mechanical rooms.
   b. And within 50’ total pipe length of connected vibration-isolation equipment (chillers, pumps, air handling units, pressure reducing stations, etc.):

2. Piping shall be isolated from the building structure by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than ½" Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to ½", Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least ¼" static deflection.
4. Where lateral support of pipe risers is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
6. Provide flexible pipe connections on all piping connected to all isolated equipment, when required by manufacturer, and wherever shown on the drawings.

3.2 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolation Mounts:

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases, which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called to herein.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beam joists. Provide suitable intermediate support members as necessary.
6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360º about the rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze, which is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and non-isolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment vibration-isolated with Type FSNTL isolators shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide ¼" clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases:

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall

apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.

2. Unless otherwise indicated, there is to be a minimum operating clearance of 2" between inertia bases or steel frame bases and the floor beneath the equipment. Position isolator mounting brackets and adjust isolators so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Flexible Duct Connections:

1. Sheet metal ducts and plenum opening shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections:

1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Restraints:

1. Snubbers shall be adjusted to clear the equipment base and to provide lateral restraint during on-off cycling, but be out of contact during normal operation of the equipment.
2. Thrust restraints shall be attached at the centerline of thrust and symmetrically on each side of the unit. The two rods of the thrust restraint shall be axially aligned. This may require modified brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Resilient Penetration Sleeve/Seals:

1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.
   a. At minimum, provide resilient penetration seals at all Mechanical, Equipment and Fan Room Penetrations.

3.3 ISOLATOR SCHEDULE

UNIT	ISOLATOR TYPE	MINIMUM STATIC DEFL.(IN.)	BASE TYPE	REMARKS
Air Handling Units (Floor Mounted)	FSN (Note 1)	1.5		Thrust restraints if internally isolated.
Air Handling Units Suspended	DSN	0.35		Thrust restraints if internally isolated.
Rooftop Air Handling Units	BC-1	1.5	BC-1	
Inline Fans (Suspended)	HSN	2		
Pumps (Inline)	HSN	0.75		

Pumps (Basemount)	BIB (Note 3)	1.5		
Utility Fans (Floor Mounted)	FSNTL	2		
Refrigeration Reciprocating Compressors, Condensing Units or Chillers	FSN	1.5		
Self-Contained Air Conditioning Units	FSN (Note 1)	1.5		Thrust restraints if internally isolated.
Heat Pumps (Ceiling Mounted)	DSN	1.0		
High Pressure Ductwork in Mechanical Equipment Rooms	DSN	1.0		

Notes:

(1) External isolator may be omitted if units have internally isolated fans and no other rotating or reciprocating components.
(2) Isolators for fan coil units should be either HSN with 0.75" minimum static deflection or be equivalent to Mason Industries Type HN with 0.35" minimum static deflection.
(3) For slab-on-grade installations isolators are not required. Refer to section 23 21 23.

3.4 INSPECTION AND COORDINATION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the Work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

D. Bring to the Architect's attention, prior to installation, any conflicts with other trades which may result in unavoidable rigid contact with equipment or piping as described herein, duct to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor's expense.

E. Bring to the Architect's attention, any discrepancies between the Specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

3.5 FIELD QUALITY CONTROL

A. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

B. Upon completion of installation of all vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report, in writing, any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as improperly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Plastic Pipe Markers and method of application.
2. Engraved Plastic Laminate Sign.
3. Equipment label and valve tag schedules shall be submitted to review as an MS Excel digital file.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products.

B. Where more than a single type is specified for an application, selection is Installer's option, but provide a single selection for each application.

2.2 PLASTIC PIPE MARKERS (TYPE A)

A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.

B. For Pipes Less Than Six Inches (including insulation if any): Provide full-band pipe markers, extending 360º around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than ¾" wide; full circle at both ends of pipe marker, tape lapped 1-½".

C. For Pipes Six Inches and Larger (including insulation if any): Provide either full-band or strip-type markers, but not narrower than 3 x letter height, taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-½" wide; full circle at both ends of pipe marker, tape lapped 3".

D. Lettering: Manufacturer's pre-printed wording which conforms to contract document system descriptions.

E. Where work is an extension or alteration of an existing system, new markers shall match existing terminology for systems which are modified or added by this work.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering or as a separate unit of plastic (to accommodate both directions).

G. Pipe Size: All insulated pipes shall be labeled to indicate pipe size.

2.3 STENCILING (TYPE B)

A. Using a color contrasting to the surface to identify, spray or brush paint through neatly cut stencils.

B. Lettering shall conform to wording on contract documents. Size shall be in accordance with ANSI A13.1.

2.4 BACKGROUND COLOR AND STENCILING (TYPE C)

A. In addition to the requirements above, paint a background color band in accordance with ANSI A13.1.

2.5 VALVES TAGS

A. Brass Valve Tags: Provide manufacturer's standard 19 ga brass tag; approximately 1-½" round wit ½" high black filled numbers and 3/16" top hole.

1. Numbers shall be sequential in accordance with schedule below.
2. Provide separate numbering for each legend sequence. Provide separate sequences for the following:
   a. Geothermal Condenser Water (GCW)
   b. All other systems (No legend)

B. Valve Tag Fasteners: Manufacturer's standard chain (wire link or beaded type), or S-hooks.

2.6 VALVE SCHEDULE

A. Provide schedule for each piping system, as defined on the drawings, and below, typewritten and reproduced on 8-½" x 11" bond paper.

B. Tabulate valve number, piping system, system legend (as shown on tag), location of valve (room or space), and variations for identification (if any).

C. Provide piping schematic for each system as defined below in Part 3.

D. In addition to mounted copies, furnish extra copies for maintenance manuals as specified.

E. Valve Schedule Frames: For each page of the valve schedule, provide a glazed frame, with screws for removable mounting on masonry walls.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, 1/16" thick, black with white core (letter color).

B. Fastening:

1. Screws
2. Rivets
3. Permanent Adhesive

C. Lettering and Graphics:

1. Coordinate names, abbreviations and other designations used in the mechanical identification work, with the corresponding designations shown, specified or scheduled in the construction documents.
2. In addition, for heating or cooling units and exhaust fans, identify area served.

PART 3 - EXECUTION

3.1 GENERAL

A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting.

B. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

A. General: Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white, whichever provides most contrast with ductwork color.

B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50’ spacing along exposed runs.

C. Access Doors: Provide stenciled or plastic laminate type signs on each duct or equipment mounted access door in ductwork and housings, indicating the purpose of the access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.3 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers on piping of the following systems and include arrows to show normal direction of flow.

1. Geothermal condenser water (supply and return).
2. Refrigerant piping (suction, liquid, hot gas bypass).
3. Any other piping system as indicated on the drawings, or as required to match existing.

B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces above accessible ceilings, in accessible maintenance spaces, including chases, and above ceiling:

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where there could be a question of flow pattern.
3. Near locations where pipes pass through walls, floors, or ceilings, or enter non-accessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 25’ along each piping run.
6. Within 6’ of access doors above otherwise non-accessible ceilings and chases.

C. Type:

1. Normally exposed to view - Type A or C.
2. Normally concealed from view - Type B.

3.4 VALVE IDENTIFICATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, hose bibs, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Mount framed valve schedules with piping schematics in each MER.

C. Identify each valve tagged on as-built drawings.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

A. Install an engraved plastic laminate sign on or near each major item of mechanical equipment.

1. Provide signs for the following general categories of equipment and operational devices:

a. Evaporative Coolers
b. Fans
c. Air Handling Units
d. Condensing Units
e. Packaged Air conditioning Units (including Rooftop Units)
f. Motor Starters and Variable Frequency Drives (Mount near starter)
g. Cabinet Heaters
h. Terminal units (VAV, CAV, etc.)
i. Heat Pumps
j. Pumps
k. Heat Exchangers

B. Provide engraved plastic laminate nameplate on every new piece of equipment not already provided with one in accordance with Section 23 05 02 of the specifications.

C. Identify area served, if applicable.

3.6 NON-POTABLE WATER IDENTIFICATION

A. Provide an engraved plastic laminate sign.

1. Legend: “Non-Potable Water”.
2. Location: At each outlet of piping downstream of backflow preventer, (e.g. Boiler Room hose bibb).

END OF SECTION

SECTION 23 05 93

TEST-ADJUST-BALANCE

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. Work of this section shall be completed by a sub-contractor of the HVAC contractor.

B. The Balancing Contractor shall not be a sub-contractor of any other Division 21, 22 or 23 Contractor.

1.2 QUALITY ASSURANCE

A. Qualification:

1. Work shall be done by a firm certified by the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC), or the firm shall have technicians certified by the “National Training Fund Sheet Metal & Air Conditioning Industry”.
2. The firm shall be an independent testing and balancing form specializing in testing and balancing of environmental systems.
3. The firm shall have an experience record of not less than five (5) years experience in the TAB industry.

B. Industry Standards: Comply with the following:

1. HVAC Systems-Testing, Adjusting, Balancing published by Sheetmetal and Air Conditioning Contractors National Association, Inc. (SMACNA).
2. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems published by National Environmental Balancing Bureau. (NEBB).
3. ASHRAE Systems Handbook. Testing, Adjusting and Balancing.

C. Registration: Work shall be done under the supervision of a professional engineer registered in the jurisdiction of the work. Engineer shall be available for all meetings and interpretation of all materials in the report.

D. Pre-qualification of TAB Contractor.

1. The firm must have experience and qualifications satisfactory to the consulting mechanical engineer and must be accepted by him prior to bidding.
2. Firms desiring approval to provide work under this section shall submit a booklet indicating procedures and data forms that they would use in the performance of the work.
3. Submittals shall be in accordance with Section 23 05 02.
4. Only firms which have been approved by the mechanical engineer may provide work under this section.

PART 2 - PRODUCTS

2.1 PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. Sequence work to commence after completion of system and start-up procedures and schedule completion of work before Substantial Completion of Project.

B. The project will be completed in phases and it will be necessary to balance new and existing equipment at the end of each phase.

1. Assume that any equipment installed in a phase must be balanced in its installation phase.
2. Assume that any equipment serving more than a single space will need to be rebalanced at the turnover of each phase after installation.
3. Assume that all equipment will require final balancing after the completion of the final phase.
4. Submit preliminary balancing reports at the end of each phase. Submit final balancing report at the completion of final phase.

C. Examine the installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable.

D. Notify the Contractor in writing of conditions detrimental to the proper completion of the test-adjust-balance work.

1. Do not proceed with the work until unsatisfactory conditions have been corrected.
2. Provide Engineer/Architect with a copy of the notification.

E. Adjust flows to within 10% of values shown. If design flows cannot be obtained within specified limits the Balancing Contractor will perform the following (at the minimum):

1. Measure and record major pressure drops in the system.
2. Consult with the Engineer and Installer as required.
3. Upon receiving written directions to proceed and after any corrections are performed, re-balance affected portion of system.

F. Optimization: Work closely with the controls contractor to optimize setpoints.

1. Establish the minimum air static pressure or water differential pressure for variable or bypass flow system.
2. Establish the position of minimum outside air dampers, damper/valve and sequencing relays.

G. Calibration: Be responsible for calibration of flow measurement devices used as input to the temperature control system. All air systems flow measurement stations including VAV terminals shall be calibrated against a pitot tube traverse or air diffuser capture hood. Balancing contractor shall assure accuracy of all flow measurement devices or shall report on their failure to be accurate.

H. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in a manner recommended by the original Installer.

I. Make all final readings for each system at the same time, and after all adjustments have been made.

J. Mark equipment settings, including damper control positions, balancing cocks, circuit setters, valve indicators, fan speed control settings and similar controls and devices, to show final settings at completion of test-adjust-balance work.

1. Mark with paint or other suitable permanent identification material.

K. Check all new thermal overloads.

1. Identify improperly protected equipment in report.

L. All piping and equipment shall be tested; labor including standby electrician, materials, instruments and power required for testing shall be furnished unless otherwise indicated under the particular section of the Specification.

M. Tests shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

N. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their ratings.

O. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architects.

P. Any damage resulting from tests to any and all trades shall be repaired and damaged materials replaced, all to the satisfaction of the Architect.

Q. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed below.

R. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated and depends upon the operation of other equipment, systems and controls for proper operation, functioning and performance, and latter shall be operated simultaneously with the equipment or system being tested.

S. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the design drawings. Replace sheaves if required to meet design conditions.

T. All pumps and piping systems shall be completely balanced by the adjustment of the plug cocks, globe valves or other control devices, to obtain the flow quantities indicated on the design drawings.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

E. Examine equipment performance data including fan and pump curves.

F. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and equipment with functioning controls is ready for operation.

G. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor, and functioning.

H. Examine strainers to verify that mechanical contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.

I. Examine two-way valves for proper installation and function.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checklists, as described in the "AABC National Standards for Total System Balance," for use by systems installers in verifying system readiness for TAB. These shall include, at a minimum, the following:

1. Airside:
    a. Ductwork is complete with terminals installed.
    b. Volume, smoke and fire dampers are open and functional.
    c. Clean filters are installed.
    d. Fans are operating, free of vibration, and rotating in correct direction.
    e. Variable-frequency controllers' start-up is complete and safeties are verified.
    f. Automatic temperature-control systems are operational.
    g. Ceilings are installed.
    h. Windows and doors are installed.
    i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:
    a. Piping is complete with terminals installed.
    b. Water treatment is complete.
    c. Systems are flushed, filled and air purged.
    d. Strainers are pulled and cleaned.
    e. Control valves are functioning per the sequence of operation.
    f. Shutoff and balance valves have been verified to be 100 percent open.
    g. Pumps are started and proper rotation is verified.
    h. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
    i. Variable-frequency controllers' start-up is complete and safeties are verified.
    j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL REQUIREMENTS

A. At a minimum, measure, adjust and report the following:

1. Fans:
   a. Inlet and outlet pressure
   b. Air flow
   c. Fan speed
   d. Motor amps and KW
2. Ductwork Systems:
   a. Air flow at each inlet and outlet.
   b. Blade angles at all adjustable diffusers.
   c. Filter pressure drop.
   d. Outside air percentage at minimum and maximum setting.
   e. Air flow at supply, return, outside air and exhaust mains to determine total air flow.
3. Coils:
   a. Air flow.
   b. Inlet and outlet air static pressure.
   c. Inlet and outlet air temperature.
   d. Water flow.
   e. Inlet and outlet water pressure.
   f. Inlet and outlet water temperature.
   g. KW draw on electric coils.
4. Pumps:
   a. Water flow
   b. Inlet and outlet pressure
   c. Motor amps and KW
5. Radiation and Convectors:
   a. Inlet and outlet water temperature
   b. Air temperature (room)
   c. KW draw
6. Cabinet Heaters, Unit Heaters:
   a. Entering air temperature
   b. Leaving air temperature
   c. KW draw
7. Unit Ventilators:
   a. CFM
   b. Entering air temperature
   c. Leaving air temperature
   d. Inlet and outlet water temperature
   e. Water flow
   f. Outside air percentage
8. Heat Pump Units (water cooled):
   a. Perform tests for individual components present in units in accordance with specific requirements above.
   b. At full heat:
      1) EAT
      2) LAT
      3) EWT
      4) LWT
   c. At full cooling: (Check at minimum outside air):
      1) EAT (DB/WB)
      2) LAT (DB/WB)
      3) EWT

4) LWT
5) Ambient temperature
6) Suction and discharge pressures
7) Oil pressure
8) Compressor amps and KW
9) Minimum air flow rate.

9. Air-Cooled Condensing Units:
   a. Ambient temperature
   b. Suction and discharge pressure
   c. Oil pressure
   d. Compressor amps and KW
   e. Fan amps and KW
10. Packaged Air Conditioning Units:
   a. Perform tests for individual components present in units in accordance with specific requirements above.
   b. At full heat: (Check at minimum outside air):
      1) EAT
      2) LAT
   c. At full cooling: (Check at minimum outside air):
      1) EAT (DB/WB)
      2) LAT (DB/WB)
      3) Ambient temperature
      4) Suction and discharge pressures
      5) Oil pressure
      6) Compressor amps and KW
      7) Minimum air flow rate.
11. Heat Exchangers:
   a. Cooler fluid inlet and outlet temperatures
   b. Cooler fluid flow
   c. Warmer fluid inlet and outlet temperatures
   d. Warmer fluid flow
12. All Exhaust Hoods:
   a. Face velocity

B. Refer to other sections of these specifications for additional requirements.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Scope: All air systems are to be balanced.

B. Before any adjustments are made, check for:

1. Dirty filters, coils, or air intakes
2. Duct leakage
3. Filter leakage
4. Damper leakage, or blockage
5. Equipment vibrations
6. Correct damper operation

C. Simulate a pressure drop across filters equal to that when 50% loaded with dust.

1. Check fan motor amps with clean filters and simulated loaded filters, and report.

D. Procedure:

1. Measure and report all supply, return, exhaust, and outside air systems by means of (4) four methods:
   a. Individual air inlets and outlets.
   b. Pitot traverses of main supply, return, exhaust and outside air ducts.
   c. Rotating valve or velocity grid traverse of coils or filters.
   d. Plot operating point on fan curve. Include compensation for effects of altitude and inlet vanes.
2. Above measurements shall be made with system in normal, full load condition.
   a. Systems with economizers shall be measured at minimum outside air and 100% outside air.
   b. Systems with 100% outside air capability or evaporative cooling sections shall be measured at maximum outside air.
   c. VAV systems shall be measured at the zone level at maximum air condition, and at the main at the system diversity condition.
3. Make main duct traverses or coil/filter traverses and report operation at all other operating conditions (as applicable).
   a. Economizer operation
   b. Unoccupied mode
   c. Smoke evacuation mode
   d. Pre-cool mode
   e. Fail over mode
   f. Two-speed fans
   g. All VAV terminals driven to maximum position
4. Set fan speed such that under no condition will the motor exceed the service factor rating when operating in any of the above possible modes.
5. Measure fan motor amps in each of the above possible operating modes (clean filters).

E. Adjust Air Systems to provided proper air pressure relationships as shown by relative air quantities or as indicated on the drawings.

1. Review drawings for room by room pressure relationships and use a smoke candle to prove proper relative air flow.

F. Adjust distribution system for uniform space temperatures free from objectionable drafts and noise.

G. Exchange sheaves and belts as required to adjust the RPM of all fans so they handle specified air quantity.

H. Set minimum outside air quantities.

I. Prepare test reports for both fans and outlets. Obtain approved submittals and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

J. Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.

K. For variable-air-volume systems, develop a plan to simulate diversity.

L. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

M. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

N. Verify that motor starters are equipped with properly sized thermal protection.

O. Check condensate drains for proper connections and functioning.

P. Check for proper sealing of air-handling-unit components.

Q. Refer to other sections of these specifications for additional requirements

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Retain this article if using constant-volume air systems.

B. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

C. Measure total airflow.

1. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
2. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
3. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
4. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

D. Measure fan static pressures as follows:

1. Measure static pressure directly at the fan outlet or through the flexible connection.
2. Measure static pressure directly at the fan inlet or through the flexible connection.
3. Measure static pressure across each component that makes up the air-handling system.
4. Report any artificial loading of filters at the time static pressures are measured.

E. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

F. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust sub-main and branch duct volume dampers for specified airflow.
3. Re-measure each sub-main and branch duct after all have been adjusted.

G. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure airflow at all inlets and outlets.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after all have been adjusted.

H. Verify final system conditions.
1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust, if necessary.
6. Measure and record all operating data.

7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located 2/3 of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control setpoint so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    a. Adjust controls so that terminal is calling for maximum airflow (note some controllers require starting with minimum airflow. Verify calibration procedure for specific project).
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot deck and cold deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

B. After all terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
2. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
3. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
4. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
5. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

C. Measure fan static pressures as follows:

1. Measure static pressure directly at the fan outlet or through the flexible connection.
2. Measure static pressure directly at the fan inlet or through the flexible connection.
3. Measure static pressure across each component that makes up the air-handling system.
4. Report any artificial loading of filters at the time static pressures are measured.

D. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

1. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
2. Verify all terminal units are meeting design airflow under system maximum flow.

E. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure setpoint to the most energy-efficient setpoint to maintain the optimum system static pressure. Record setpoint and give to controls contractor.

F. Verify final system conditions as follows:

1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.
6. Verify tracking between supply and return fans.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Scope: Balance all hydronic systems.

B. Prepare test reports for pumps, coils, heat exchangers and other equipment. Obtain approved submittals and any manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

C. Verify that hydronic systems are ready for testing and balancing:

1. Check liquid level in expansion tank.
2. Check that makeup water-has adequate pressure to highest vent.
3. Check that control valves are in their proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Before any adjustments are made:

1. Check temperature control valve operation.
2. Check pump rotation.
3. Adjust pressure reducing valve.
4. Remove any roughing strainer screens in systems.

E. Using system flow meters, adjust the quantity of fluid handled by each pump and supplied to each coil, piece of radiation, heat exchanger, cross-over bridge, bypass, etc., to meet design requirements.

F. Procedure:

1. Measure and report all hydronic and domestic water recirculation systems by all of the below means which are applicable.
    a. System, pump, branch, or terminal flow measuring stations.
    b. Terminal or heat exchanger pressure drop, compare to submittal data.
    c. Plot operating point on pump curve. Include compensation for effects of temperature, viscosity and density.
2. Above measurements to be made and reported at full heating/cooling load.
    a. For 3-way valve terminals/heat exchangers set bypass flow to equal coil flow.
    b. For primary/secondary systems, set crossover/bridle to have constant flow at all conditions.

G. Refer to other sections of these specifications for additional requirements

3.9 FIELD TESTING OF HYDRONIC SYSTEMS

A. During construction properly cap or plug all lines so as to prevent the entrance of sand, dirt, etc. The system of piping shall be blown through wherever necessary after completion (for the purpose of removing grit, dirt, sand, etc., from all equipment and piping), for as long a time as is required to thoroughly clean the apparatus.

B. Use anti-freeze solution for piping to be tested in winter.

C. All piping shall be tested as hereinafter specified. Tests shall be made after erection and before covering is applied or piping painted or concealed and as sections of mains and groups of risers are completed. The extent of the work completed before pressure tests are made shall be determined by the Architect.

D. All piping shall be tested to a hydrostatic pressure at least 1-1/2 times the maximum designed working pressure unless a higher pressure is required elsewhere (but not less than 50 psi) for a sufficiently long time to detect all leaks and defects; and after testing shall be made tight in the most approved manner. Tests shall be repeated once after leaks and defects have been repaired. When automatic-control valves and similar devices are incapable of withstanding test pressures applied to piping, such devices shall be removed, or otherwise protected during tests. After completion of such tests, devices shall be installed and tested with the operating medium to operating pressures.

E. The following systems shall be tested for four consecutive hours and proved tight. Leaks shall be remedied by replacing defective work. Test shall be performed at 1-1/2 times working pressure unless a higher pressure is required elsewhere; minimum pressures listed in table below.

Item	Hydrostatic Field Test
Overflow and drain	50 psi
Cold Water (domestic)	100 psi
Geothermal/Condenser water	100 psi
Chemical Treatment	
- Geothermal/Condenser water	100 psi
Vent - water discharge	100 psi

F. Leaks appearing during the various pressure tests shall be corrected by replacing all defective materials or welds and subsequent tests shall be made until the piping is found perfect. Caulking of screwed joints or peening of welds is prohibited. Wherever it is necessary to cut out a weld and the ends of the pipe cannot be conveniently brought together, then a short piece of pipe shall be fitted in and welded as approved by the Architect.

G. Provide all other tests required by Building Department, Fire Department and other Authorities having jurisdiction.

H. Running Test of Piping Systems:

1. When directed, any section of the work, after it has been completed and otherwise satisfactorily tested, shall be put in actual operation and operated for a period of two days of 24 hours each, during which time any defects which may appear shall be remedied and any adjustment which may be necessary shall be made.
2. During the time of the tests, repack all valves, make all adjustments and otherwise put the apparatus in perfect condition for operation, and instruct the Owner's representative in the use and management of the apparatus.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

C. Verify that the differential-pressure sensor is located per the contract documents.

D. Determine if there is diversity in the system.

E. For systems with no diversity:

F. Follow procedures outlined in "Procedures for Constant-Flow Hydronic Systems" Article.

G. Prior to verifying final system conditions, determine the system differential-pressure set point.

H. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

I. Mark all final settings and verify that all memory stops have been set.

J. For systems with diversity:

K. Determine diversity factor.

L. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

M. Follow procedures outlined in "Procedures for Constant-Flow Hydronic Systems" Article.

N. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance the terminals that were just opened.

O. Prior to verifying final system conditions, determine the system differential-pressure set point.

P. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

Q. Mark all final settings and verify that all memory stops have been set.

3.11 PROCEDURES FOR HEAT EXCHANGERS

A. Balance water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Check settings and operation of safety and relief valves. Record settings.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase/Hertz (Hz)
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test the manual bypass of the controller to prove proper operation.

3.13 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.14 PROCEDURES FOR COILS

A. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.15 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak conditions, the engineer may request a temperature recheck to further verify performance at near-peak conditions.

B. Duct Leakage Testing:

1. Witness the duct pressure testing performed by the mechanical/installing contractor.
2. Verify that proper test methods are used and that leakage rates are within specified tolerances.
3. Report any deficiencies observed.

C. Controls Verification

1. In conjunction with system balancing perform the following:
   a. Work with the temperature control contractor to ensure the system is operating within the design limitations, and gain a mutual understanding of intended control performance.
   b. Confirm that the sequences of operation are in compliance with the approved drawings.
   c. Verify that controllers are calibrated and function as intended.

d. Verify that controller setpoints are as specified.
e. Verify the operation of lockout or interlock systems.
f. Verify the operation of all valve and damper actuators.
g. Verify that all controlled devices are properly installed and connected to the correct controller.
h. Verify that all controlled devices travel freely and are in the position indicated by the controller: open, closed, or modulating.
i. Verify the location and installation of all sensors to ensure they will sense only the intended temperatures, humidity, or pressures.

3.16 FINAL TEST AND BALANCE REPORT

A. Provide a general information sheet listing:

1. Instruments used:
   a. Most recent calibration date.
2. Method of balancing.
3. Altitude correction.
4. Manufacturer's performance data for all air devices used.

B. Provide data sheets for all equipment, including motors and drives, listing:

1. Make
2. Size
3. Serial number
4. Capacity Rating
5. Amperage
6. Voltage input
7. Thermal heater size for each motor
8. Operating speed of driver and driven devices
9. Any additional pertinent performance data

C. Include design and final values for all items listed in Detailed Requirements, and totals for each system.

D. Provide data sheets showing:

1. Air flow at each inlet and outlet
2. Instrument used
3. Velocity reading
4. Manufacturer's free area factors

E. Provide recap sheet with explanation for each device not meeting specified performance. Contractor shall be responsible for correcting all deficiencies noted in the TAB report. Upon completion of correction of deficiencies, the TAB contractor shall retest all devices and provide an updated report.

F. Provide a set of prints with equipment, inlets and outlets marked to correspond to data sheets.

3.17 COMMISSIONING

A. Reference Section 23 08 00 for commissioning scope.

B. Provide all necessary personnel, tools and equipment to comply with the commissioning scope.

END OF SECTION

SECTION 23 07 00

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Insulation.
2. Jackets, coatings and protective finishes.
3. Sealers, mastics and adhesives.
4. Fitting covers.
5. Manufacturer's installation details for fire rated duct wrap.

1.2 FLAME AND SMOKE RATINGS

A. Provide insulation tested on a composite basis (insulation, jacket, covering, sealer, mastic and adhesive) complying with the following for:

1. Flame Spread: 25 or Less
2. Smoke Developed: 50 or Less
3. Method: ASTM E84 (NFPA 255), UL 723

B. Accessories such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above. All products shall bear UL labels indicating the above are not exceeded.

1.3 PRODUCT DELIVERY

A. Deliver insulation products in factory containers bearing manufacturer's label showing fire and smoke hazard rating, density and thickness.

B. Protect insulation against, dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

C. Store insulation in original wrappings and protect from weather and construction traffic.

1.4 DEFINITIONS

A. Exposed Location: Located in mechanical rooms or other areas exposed to view.

B. Concealed Location: Locations not exposed to view, such as pipe chases, furred spaces, attics, crawl-spaces and above wall to wall suspended ceilings.

1.5 STANDARDS

A. Comply with the latest edition of National Commercial and Industrial Insulation Standards.

B. Provide certifications or other data as necessary to show compliance with these Specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Manufacturers:

1. Design Basis: Johns-Manville
2. Other Acceptable Manufacturers:
   a. Armacell
   b. Foster
   c. Childers
   d. Owens-Corning
   e. Knauf
   f. KFlex USA
   g. Imcoa
   h. Pittsburgh Corning

B. Materials:

1. Fiberglass Pipe Insulation with Vapor Barrier: Johns-Manville Micro-Lok heavy density pipe insulation with AP-T jacket or Owens-Corning Fiberglass Corp. ASJ/SSL-II.
2. Fiberglass Pipe Fitting Insulation: Johns-Manville "Zeston" fitting covers with factory-cut fiberglass insulation insert. Insulation blanket with foil tape and tie-wire will not be acceptable.
3. Flexible Unicellular Pipe Insulation: Armstrong Armaflex, II or Therma-cel By Nomaco.
4. Cellular glass with vapor barrier coating: Pittsburgh Corning.
5. Rigid Closed Cell Insulation: ITW Insulation Trymer 2000 XP (not for use indoors).
6. Vapor Barrier Mastic: Foster 30-65 or Childers CP-34; permeance shall be 0.03 perms or less per ASTM E96. Mastic must meet California Dept of Public Health (CDPH) Standard Method Ver. 1.1, 2010 Small Scale Environmental Chamber Test for VOCs for CA Specification 01350 and LEED IEQ 4.2.
7. Weather Barrier Mastic: Foster 46-50 or Childers CP-10/11. For use on hot service pipe and ducts.
8. Lagging Adhesive: Foster 30-36 or Childers CP-50AMV1.
9. Fiberglass Adhesive: Foster 85-60 or Childers CP-127.
10. For hot pipe insulation material shall be rated at 650˚F.

C. Thickness: (Thickness listed below are minimum required. Provide thickness required by Local Building or Energy Codes).

1. Hydronic Piping:

2.2 Piping Insulation Thickness (inches)

Operating Temperature	Insulation Conductivity[a]		Pipe Size				
°F	Btu*in/ (h*ft^2*F)	Mean Rating Temperature, F	<1"	1" to < 1-1/2"	1-1/2" to < 4"	4" to < 8"	≤ 8"
Geothermal/Condenser Water							
40°F - 60°F	0.21-0.27	75	1.5	1.5	1.5	1.5	1.5
Solar Thermal Water							
141°F - 200°F	0.25-0.29	125	1.5	1.5	2	2	2

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$T = r\{(1+t/r)^{K/k}-1\}$

where:

T: minimum insulation thickness,

r: actual outside radius of pipe,

t: insulation thickness listed in the table for applicable fluid temperature and pipe size,

K: conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu x in/h x ft^2 x F) and

k: the upper value of the conductivity range listed in the table for the applicable fluid temperature.

1. Refrigerant Piping (Suction and Hot Gas Bypass) and AC Condensate
   a. Up to 1" – ¾"
2. Heat Traced Piping
   a. Size 2" and smaller: 1" (minimum)
   b. Size 2½" and larger: 2" (minimum)
3. Condensate Drain Piping: 1"

B. Application: Unless otherwise indicated, use the following:

1. Inside, concealed: Fiberglass pipe insulation with vapor barrier.
2. Inside, exposed: Fiberglass pipe insulation with vapor barrier and PVC jacket (jacket not required in mechanical rooms).
   a. A vapor barrier mastic compatible with the PVC shall be applied around the edges of the adjoining pipe insulation and on the fitting cover throat overlap seam. The PVC fitting cover is then applied and shall be secured with pressure sensitive pearl gray Z-Tape along the circumferential edges. The tape shall extend over the adjacent pipe insulation and have an overlap on itself at least 2" on the downward side.
   b. 2 or more layers of the Hi-Lo Temp insulation inserts shall be applied with the first layer being secured with a few wrappings of fiberglass yarn.

c. Refrigerant systems and cold systems in severe ambient conditions: Fittings shall be insulated to a full thickness the same as the adjacent pipe insulation, with insulation which has been mitered to conform to the PVC fitting cover. An intermediate vapor barrier mastic and reinforcing mesh compatible with the PVC shall be applied directly onto the insulation, completely sealing the insulation. The PVC fitting cover is then applied and shall be secured with pressure sensitive pearl gray Z-Tape along the throat seam and the circumferential edges overlapping itself 2" on the downward side.
d. Qualifications for Using Insulation: Use one Hi-Lo Temp insert for each additional 1" of pipe insulation.
e. Fitting Cover: the temperature of the PVC fitting cover must be kept below 150˚F by the use of proper thickness of insulation and by keeping the PVC cover away from contact with, or exposure to, sources of direct or radiant heat.

3. Refrigerant systems pipe insulation shall be closed cell expanded form in a tubular form similar to Armaflex as made by Armstrong Company. Pipe insulation shall meet flame spread index of 25 and smoke density of 50 when tested in accordance with ASTM-E-84
4. Outside, protected: Fiberglass pipe insulation with vapor barrier and aluminum jacket.
5. Outside, exposed to weather: Rigid closed cell pipe insulation with aluminum jacket.
6. Below grade or slab:
   a. Pipe size 1½" and less: Single piece of flexible closed cell insulation slipped over soft annealed copper tube without slitting insulation.
   b. Pipe size 2" and larger: Pre-Insulated System (Perma-Pipe, or equal) with rigid closed cell insulation and shrink fit jacket.
7. All fittings, valves and flanges for pipe sizes 3" and below shall be insulated with preformed molded fiberglass insulation of same thickness as the adjoining pipe insulation, secured with No. 20 gauge galvanized annealed steel wire covered with Zeston 2000 molded PVC fitting covers as manufactured by Manville, or equal.
8. All fittings, valves and flanges for pipe sizes 4" and larger shall be insulated with fabricated mitered segments of pipe insulation of same thickness as the adjoining pipe insulation, secured with no. 20 gauge galvanized annealed steel wire and covered with Zeston 2000 molded PVC fitting covers as manufactured by Manville or equal.
9. Direct contact between pipe and hangers will not be accepted. Hangers shall pass outside of a metal saddle which shall cover a section of high density insulation of sufficient length to support pipe without crushing insulation. Hangers shall not pierce insulation and all vapor barriers shall be unbroken and continuous. High density insulation shall be one of the following:
   a. Foam glass.
   b. Fiberglass, high density, minimum of 7 lb. material or heavier.
   c. High density calcium silicate insulation. See Part 3 of this Section for high density insulation lengths.
10. At pipe supports insulation shield protection saddles and matching hanger shall be used.
11. All strainers for geothermal/condenser water and insulated condenser water piping shall be insulated and boxed in with galvanized sheet metal cover, and insulation shall be made removable.
12. The Contractor shall have the option to use Armaflex as made by Armstrong Co. pipe insulation in lieu of fiberglass hereinbefore specified for geothermal/condenser, and hot water piping insulation in fan coil units. Pipe insulation shall meet flame spread index of 25 and smoke density of 50 when tested in accordance with ASTM-E-84.
13. Provide vapor barrier dams at locations and intervals recommended by the insulation manufacturer and as described in this specification.
14. All high pressure steam insulation for straight pipe is fiberglass and shall conform to ASTM C-547, Type I. Insulation shall consist of single layer thickness. Multi-layered and/or multi-section insulation is unacceptable.

C. Flexible elastomeric insulation (25/50 flame spread/smoke developed index) is acceptable in lieu of fiberglass on cold piping (roof leaders, geothermal/condenser water, condensate drains from cooling units).

1. Use pre-molded roll on pipe sizes 3.5" and below.
2. Use either pre-molded roll or sheet on pipe sizes 4" and above, adhere insulation on 100% of the pipe. This requirement exceeds the typical industry standard of adhering to lower one-third of pipe on horizontal runs.

3. Match thickness of fiberglass insulation on all pipe sizes. Provide multiple layers when a single layer of material cannot accomplish required thickness.
4. No exposed cross section edges are permitted.

2.3 DUCT INSULATION

A. Manufacturer:

1. Design Basis: Johns Manville
2. Other Acceptable Manufacturers:
   a. Owens-Corning
   b. Certainteed
   c. Knauf

B. Materials:

1. Flexible fiberglass Ductwork Insulation: Johns-Manville Microlite XG, with FSK factory applied foil-scrim-kraft vapor barrier facing, with maximum K factor of 0.25 at 75˚F mean temperature.
2. Rigid Fiberglass Ductwork Insulation: Johns-Manville 800 Series, Spin-Glas Type 814, with FSK factory applied foil-scrim-kraft vapor barrier facing, with maximum K factor of 0.23 at 75˚F mean temperature.
3. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, and similar accessories as recommended by the insulation manufacturer for the applications indicated.
4. Cellular glass: Pittsburgh Corning with vapor barrier.

C. Thickness: (Thickness listed below are minimum required. Provide thickness required by Local Building or Energy Codes).

Ductwork Insulation				
Location	Exposed/Concealed	Insulation Type	R-Value	Thickness
Supply Ductwork (unlined)				
Indoor	Exposed	Rigid	R-6	1½"
Indoor	Concealed	Flexible	R-6	2"
Indoor, Unconditioned Space	Exposed	Rigid	R-6	1½"
Indoor, Unconditioned Space	Concealed	Flexible	R-6	2"
Outdoor	See Outdoor Duct Insulation Section			
Return Ductwork (unlined)				
Indoor	Exposed	Rigid	R-6	1½"
Indoor	Concealed	Flexible	R-6	2"
Indoor, Unconditioned Space	Exposed	Rigid	R-6	1½"
Indoor, Unconditioned Space	Concealed	Flexible	R-6	2"
Outdoor	See Outdoor Duct Insulation Section			
Outside Air Ductwork (unlined)				
Indoor	Exposed	Rigid	R-6	2"
Indoor	Concealed	Flexible	R-6	2"
Indoor, Unconditioned Space	Exposed	Rigid	R-6	2"
Indoor, Unconditioned Space	Concealed	Flexible	R-6	2"
Outdoor	See Outdoor Duct Insulation Section			

D. Application:

1. Where energy codes require additional insulation over that listed above, provide insulation in accordance with those codes.
2. The Contractor shall have the option to use the following material: Insulation for round ducts shall be of thickness noted above and shall be fiberglass Bend-a-Board having a factory applied ASJ vapor barrier jacket secured with stables and ASJ pressure sensitive tape. Bend-a-Board is a 3.00 p.c.f. board cut into strips, adhered to jacketing it must have a UL label.
3. Adhere insulation to duct with Foster water based, fire resistant adhesive 85-60, Chiders CP-127, or approved equal, applied in 3 inch wide transverse strips at 8 inch intervals. Insulation shall be butted with facing overlapping all joints at least 2 inches and sealed with Foster fire resistant adhesive 85-60, Childers CP-127, or approved equal. For insulation with vapor barrier use Foster fire resistant vapor barrier adhesive or equal and joints without tabs shall be firmly sealed with aluminum foil tape adhered with same adhesive. Secure insulation with 16 gauge copperclad wire spaced not more than 12 inches on center.
4. Additionally, secure insulation to bottom of rectangular ducts over 24" wide with welded pins or stick clips on 18" centers coated with a vapor barrier coating.
5. Rigid duct insulation shall be fastened to duct with 12 gauge welded pins and washers, or equivalent as approved. Fasteners shall be spaced 12 to 18 inches on center, a minimum of two rows per side of duct. Secure insulation in place with suitable speed washers firmly embedded in insulation, or push a self-locking cap over pin after coating with fitting mastic type C by Owens-Corning or equal. For rigid duct insulation, seal all joints, breaks and impressions with Foster water based, fire resistant vapor barrier mastic Foster 30-65, Childers CP-34, or approved equal, and apply 5" wide joint sealing tape to all joints. All surface must be clean and dry before applying tape and mastic.
6. Insulation for exposed round ductwork shall be of the same material as specified for concealed ductwork and shall be covered with glass cloth or all service jacket smoothly adhered with Foster 85-60 or Childers CP-127 adhesive. Seal joints with 5" wide tape.

E. Acoustical Duct Lagging

1. Manufacturers:

a. Design Basis: Sound Seal
b. Other acceptable manufacturers:
    1) Kinetics Noise Control
    2) The Proudfoot Company
    3) Acoustical Solutions
c. Model: B-10 LAG/QFA-3, foil face loaded vinyl or lead barrier sheet fully bonded to a minimum 1” thick fiberglass blanket, nominal density of 1.0psf, install so jacket edges overlap by minimum of 6”. Minimum STC-27 tested by independent laboratory in accordance with ASTM E90 and E413. Minimum insertion loss (IL) value at 500Hz shall be 23. Lagging shall meet IMC flame/smoke ratings in accordance with ASTM E84.
d. Duct lining shall be rated to prevent fiber erosion at air velocities up to 4,000 FPM and shall have a minimum density of 1.5 pounds per cubic foot. The liner must be installed with sheet metal nosing at the leading edge. Exposed edges-including butt joints – shall be sealed with mastic.
e. Lining shall be contained between outer wall of duct and perforated metal inner liner of material to match the duct material. Perforations shall not exceed 3/32” diameter, free area shall be approximately 22%. Metal liner need not be perforated at fittings. Provide continuous mylar liner between the perforated liner and insulation to prevent the erosion of the insulation.
Provide transitions at end of insulated sections to adapt duct liner size to dimension of unlined ductwork. Liner and transition shall be concentric for low pressure drop.
f. Thickness shall be per thickness required for externally insulated ductwork of same function and location.

2.4 OUTDOOR DUCT INSULATION

A. Manufacturers:

1. Design Basis: Armstrong
2. Other Acceptable Manufacturers:
   a. Johns-Manville
   b. Nomaco

B. Materials:

1. Model: Armaflex
   a. Description: Flexible, cellular, elastomeric foam.
   b. Form: Sheet
2. Paint: Armaflex Finish
   a. Description: Vinyl lacquer. Contractor must coordinate color of vinyl lacquer with Architect. Submit color chart to Architect for his review.
3. Adhesive: Armstrong 520.
4. Cellular glass: Pittsburgh Corning with vapor barrier.
5. Weatherproofing Finishes for Outdoor Duct Insulation:
   a. VentureClad 1579CW Jacketing System, or equal. 13 Ply, 0.45 mm minimum thickness.
   b. Color selected by architect

C. Application:

1. All outdoor supply, return and transfer air ducts that are specified with acoustical duct lining shall be provided with 2” duct lining (minimum R=8).
2. All outdoor supply, return, and transfer air ducts that are not specified to have acoustical lining shall be insulated with two layers of one inch thick sheet on the exterior.
3. Jacketing shall be applied with minimum 2 inch overlaps facing down from the weather and the jacketing shall be secured with aluminum bands 1/2 inch by 0.020 inches and aluminum wing seals applied on 12 inch centers, with bands applied directly over butt overlaps or with Pli-Grip Rivets. Where jacketing is cut out or abuts an uninsulated surface, the joint shall be sealed with Foster 95-44, Childers CP-76, or Insul-Coustic Sure-Joint 405.
4. Over the insulated surface apply a tack coat of Foster 46-50, Childers CP-10/11, or Vi-AC Mastic and imbed in it a layer of glass cloth. A smooth finish coat of weather barrier mastic shall be applied to the entire area so that the total film thickness is a minimum of 1/8 inch. Provide high point at center, so that no water accumulation will occur.

2.5 EQUIPMENT INSULATION

A. Manufacturer:

1. Design Basis: Johns Mansville
2. Other Acceptable Manufacturers:
   a. Armstrong
   b. Certainteed
   c. Owens-Corning
   d. Knauf
   e. Pittsburgh Corning

B. Materials:

1. Model: Pipe and tank insulation.

Description: Flexible board type insulation. 3 PCF glass fiber insulation with all purpose jacketing. Maximum thermal conductivity .32 BTU-IN/(hr-FT^2-ºF) at 150ºF. Glass fibers oriented such that insulation will conform to rounded shapes while maintaining high compressive strength.

2. Model: Johns-Manville 800 series, spin glass type 814.
   Description: 3 PCT density rigid glass fiberboard, with all purpose jacketing. Maximum thermal conductivity .27 BTU-IN/hr-FT^2--ºF).
3. Jacketing Material: PVC or aluminum jacketing material, except as otherwise indicated. Seal all joints.
4. Fiberglass: Johns-Manville Micro-Lok 850 insulation with APT jacket.
5. Flexible Unicellular Insulation: Armstrong Armacell sheet form.

C. Application:

1. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, metal covers, adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

2.6 KITCHEN GREASE HOOD EXHAUST DUCT INSULATION

A. Manufacturers (all components to be by one manufacturer):

1. 3M
2. Unifrax
3. Nelson
4. Thermal Ceramics
5. Pyroseat
6. Vesuvius
7. ETS Schaefer

B. Materials:

1. Lightweight, non-asbestos, high temperature inorganic ceramic fiber blanket wrap.
2. Insulation to be fully encapsulated in reinforced foil.
3. Sufficient thickness to provide two (2) hour fire resistant enclosure.
4. Fibers to be non-carcinogenic and soluble in human lung tissue.
5. Zero clearance to combustibles rating.
6. As an alternate to manufactured wrap systems the contractor may, with the engineers approval, utilize 2" thick calcium silicate 11 PFC minimum density insulation wired on and finished with 1/2" thick hard plaster laid over chicken wire and troweled smooth. Finish with two (2) coats of cement over hexagonal wire. Wire shall be copperclad steel.

C. Listings and Testing :

1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
   Surface burning characteristics:
   a. Flame Spread: 0
   b. Smoke Developed: 0.
2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
4. NFPA 96.
5. NFPA 101.
6. Submit written approval from authority having jurisdiction for use of system at specified clearance.
7. Bureau of Standards and Appeals MEA #.

D. Application:

1. Insulate all kitchen grease hood exhaust duct systems from hood to exhaust fan full length, including kitchen hood above ceiling.
   a. Insulate fan housing on indoor kitchen exhaust fans
2. Wrap duct supports for two (2) hour rating.
3. Install per manufacturer's recommended installation guidelines.
4. Provide Manufacturers approved transition between fire wrap and gypsum board rated enclosures where both systems are used. Do not transition from gypsum enclosure system back to fire wrap, regardless of what may be shown on drawings.
5. Use bands and/or welded pins as required. Adhesives are not acceptable.
6. Provide rated access doors (as required) insulated to maintain two (2) hour rating and required clearance.
7. Provided fire barrier sealant, tape, rods, pins, clips, bands and other components as required to provide fully functioning system.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify acceptability of all materials which are to be used in air plenums (above ceiling, etc.). Materials must meet all requirements of Local Building Code and Authority having jurisdiction.

B. Insulation Packing:

1. Piping :
   a. Wherever piping penetrates walls, partitions, floor slabs, etc., the space between the piping and the sleeve shall be packed with mineral wool and sealed with approved type non-hardening fire resistant caulking compound for sleeves through exterior walls.
2. Ductwork:
   a. Provide 1/2" thick rigid fiberboard sleeve wherever ductwork penetrates walls, floor slabs, partitions, etc. Space between duct and wall sleeve and between duct and slab opening shall be tightly packed with mineral wool and sealed with approved type non-hardening fire resistant caulking compound.
3. Material:
   a. Packing material shall be rockwool insulation as manufactured by United Stated Gypsum Co. or equal and shall comply with Fed. Spec. HH-1-558, Form A, Class 4, K=0.24, melting point 2000˚F.

C. All Winterized Lines That Are Electrically Traced

1. The basic insulation shall be dual temperature, Manville Micro-Lok piping insulation. The insulation shall be sized to accommodate the electric heat tracing applied against the pipe surface.
2. Finish for insulation shall be aluminum jacket as specified under "Weatherproofing of Piping".

D. Contractor shall examine location where this insulation is to be installed and determine space conditions and notify the Architect in writing of conditions detrimental to proper and timely completion of the Work.

E. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION

A. Install insulation in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that insulation complies with requirements and serves intended purposes.

B. Coordinate with other work as necessary to interface installation of insulation with other components of systems.

C. All insulating materials shall be applied only by experienced workmen, in accordance with the best covering practice. All piping, duct or equipment shall be blown out, cleaned, tested and painted prior to the application of any covering.

Adhesives, sealers and mastics shall not be applied, when the ambient temperature is below 40˚F., or surfaces are wet.

3.3 PIPE INSULATION

A. Insulate the following:

1. Geothermal/condenser water piping.
2. Refrigerant suction and hot gas bypass lines.
3. Solar energy system piping.
4. All existing piping which is currently insulated and which is modified as a result of this work.
5. Condensate drain piping.
6. Heat traced piping

B. Installation:

1. Install insulation on pipe system subsequent to testing and acceptance of tests.
2. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.
3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
4. Extend piping insulation without interruption through pipe clamps, hangers, walls, floors and similar piping penetrations, except where otherwise indicated. Notched insulation will not be acceptable.
5. Install protective metal shields and saddles where needed to prevent compression of insulation. Refer to Section 23 05 29.
6. Except as noted, cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run.
   a. Install factory-molded, pre-cut or job-fabricated units (at Installer's option), except where a specific form or type is indicated.
   b. Do not cover:
      1) Valve operators.
      2) Nameplates or identification tags.
   c. Provide removable access for:
      1) Strainers.
      2) Other components requiring access for service.
7. Mark location of unions and flanges covered by insulation with permanent paint or ink, or approved label.
8. Maintain integrity of vapor-barrier jackets on insulation of cold pipes and storm drainage piping, and protect to prevent puncture or other damage. Insulation on cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold services shall be adequately insulated and vapor sealed to prevent condensation.
9. Inserts shall be installed at hangers for insulated piping. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of equal thickness to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

2-1/2" pipe size and smaller	6" long
3" to 6" pipe size	9" long

10. Provide 18 gauge galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit insulation. Extend shields up to centerline of pipe. Make shields same length as that specified above for inserts.
11. Where insulation is specified for piping, insulate similarly all connections, vents, drains, and any piping connected to system.
12. Fill surface imperfections such as chipped edges, small joints or cracks and voids or holes with insulation material and smooth all such areas with a skim coat of insulating cement.

13. Seal ends of sections with Foster 30-65 or Childers CP-34 vapor barrier mastic and reinforcing mesh to create moisture dams at:
    a. 20 ft. intervals.
    b. Valves and fittings.
    c. All hangers and supports.
14. On underground pipe insulation, install unicellular insulation on pipe without slitting insulation. Seal all transverse joints with adhesive.
15. Replace existing insulation removed or damaged because of work of this project.
16. Insulate new pipes and replace insulation on existing pipes to remain where insulation was removed or damaged by demolition or revisions.
17. Do not insulate steam traps.
18. Insulate between fingers of spiders in alignment guides.
19. Insulate between pipe and pipe saddle.
20. Perform all work in a neat and workmanlike manner. Poor work (as determined by Architect or Engineer) will be cause for rejection.
21. Specialties shall be insulated to match those of the systems to which they are connected.
22. No insulation shall be installed until the piping systems have been hydrostatically tested as specified elsewhere to the satisfaction of the Engineer.
23. Provide glass cloth and aluminum bands 18" on center on calcium silicate insulation jacket and flared-out staples on all fiberglass hot pipe insulation. Tape vapor barrier joints and seams on all cold pipe insulation.
24. Provide insulation on all horizontal runs of condenser water piping running over occupied areas to avoid condensation on pipe surfaces during winter operation of the Water Side Economizer.
25. Provide extended valve stems to maintain vapor barriers on all geothermal/condenser water valves as required.
26. In addition to the requirements above, provide ITW SARAN CX Vapor Retarder or vapor barrier mastic/reinforcing mesh on all Geothermal/condenser Water vertical elbows.
27. When available, insulate fittings with factory pre-molded fittings of the same thickness as adjoining pipe insulation.
28. When pre-molded fittings are unavailable, use a hydraulic setting cement paste.
29. Clamps and anchors on cold piping shall be insulated. Full taping of pre-molded fittings is required.
30. Insulation at pipe strainer flanges shall be arranged for ease of servicing.
31. Insulation and vapor barriers shall be properly protected at all hangers and penetrations.
32. Insulated valves shall have extended handle stems so all operators or handles are outside of the insulation system. This is particularly true of high pressure steam piping.
33. Provide factory manufactured removable covers on all steam PRV's, constructed with 2" TEMPMAT insulation, fiberglass cloth, stainless steel grommets, and stitching. Cold side shall be silicone impregnated for moisture and soiling resistance.
34. Geothermal/condenser water pumps shall be enclosed in a removable, insulated aluminum box that allows access to the pump with no disruption of piping or electrical connections, or with minimum 1-inch thick, flexible elastomeric insulation (25/50 flame spread/smoke developed index).
35. All refrigerant line accessories that are part of the suction and hot gas bypass refrigerant system (e.g. valves, vibration eliminators, P-traps, filters, etc.) shall be complete insulated.
36. All refrigerant insulation must be properly sized for the piping that it is being installed on.

    a. Insulation installed on horizontal runs of refrigerant piping will require that the insulation protection shield be installed between the insulation and the pipe hanger.
    b. All seams and joints in the insulation will be required to be sealed with the proper adhesive, for the product being use, to provide a continuous vapor barrier.
    c. Piping clamps that are in contact with the suction line are required to be covered with insulation.
    d. All thermostatic expansion valve sensor bulbs are required to be covered with insulation.

3.4 OUTDOOR PIPE INSULATION

A. Install rigid closed cell insulation with butt joints of half pipe sections staggered. Insulation shall be held in place with strapping tape. Install aluminum jacket with all joints lapped to shed water. Apply a bead of Foster 95-44 or Childers

CP-76 metal jacketing sealant at all transverse and longitudinal seams. Secure with aluminum bands, minimum of 2 per jacket section.

3.5 DUCTWORK INSULATION

A. Insulate all ductwork except the following portions of ductwork:

1. Ducts and casings internally insulated or provided with sound absorptive lining.
2. All exhaust ductwork, except where otherwise noted.
3. Return air ductwork from air conditioning systems passing through air conditioned space and/or hung ceiling of air conditioned space.
4. Return air ductwork from heating and ventilating systems, where return air ducts pass through heated areas.
5. Exposed air conditioned supply and return air ducts in air conditioned spaces if same supply or return air ducts serve that area only.
6. Exposed supply air duct from heating and ventilating systems, if same duct serves that area only.

B. Except where otherwise noted, all concealed rectangular and round ductwork shall be covered with flexible duct insulation with or without vapor barrier.

C. Install insulation materials with smooth and even surfaces, after inspection and release for insulation application. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Clean and dry ductwork prior to insulating.

E. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

F. Except as otherwise indicated, do not insulate lined ducts. However, extend duct insulation 12” beyond start of lining where lined ductwork meets insulated ductwork.

G. Maintain integrity of vapor-barrier on insulation of ducts carrying cold air, and protect it to prevent puncture and other damage. Insulation on cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold services shall be adequately insulated and vapor sealed to prevent condensation.

H. Do not install covering before ductwork has been tested and approved.

I. The finish including any vapor barrier treatment shall lap adjacent sections at both the transverse and longitudinal joints and 3" strips of matching finish material shall be adhered at the transverse joints.

J. For Outdoor Armaflex Insulation:

1. Stagger joints on multilayer applications.
2. Locate joints at sides of ducts whenever possible.
3. Use 520 adhesive to attach insulation. Provide full coverage.
4. Seal all seams and joints with adhesive.
5. Maintain full thickness at standing seams and flanges by additional layer(s).
6. Cover flexible connections.
7. Extend covering to inside face of outside wall.
8. Finish with two coats of Armaflex finish or Foster 30-64 coating.

K. The installer of the ductwork insulation shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

L. Ductwork directly connected to ovens shall be insulated to the requirements for breeching.

M. The use of flexible elastomeric insulation on ductwork is permitted as an acceptable alternative to fiberglass. Insulation shall be adhered to 100% of the duct surface area.

3.6 EQUIPMENT INSULATION

A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces, after inspection and release for insulation application.

1. Re-do poorly fitted joints.
2. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

C. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

D. Do not insulate handholes, cleanouts, ASME stamp and manufacturer's nameplate.
Provide neatly beveled edge at interruptions of insulation.

E. Insulation for factory-fabricated air handling units shall be furnished as part of units.

F. Geothermal/condenser Water Pumps:

1. Geothermal/condenser water pump and standby geothermal/condenser water pump casings shall be encased in 14 GA aluminum casings, gasketed and bolted together with brass bolts, washers and nuts, split horizontally and removable in two sections and packed with 2" thick 1lbs. density fiberglass blanket insulation. Corners shall be constructed with a frame of 2" wide 0.05" thick aluminum corner angles put together with pop rivets or all welded. Frame sides shall be cut for pipes, flanges and pump shaft.

G. Hot Equipment (Above Ambient Temperature):

1. Includes hot and heating water as well as steam equipment such as air release tanks, air separators, expansion tanks, flash tanks, vessels etc.
2. Insulate with 3" thick fiberglass U.L. labeled insulation finished with glass cloth jacket adhered and wired and coated with two coats of Foster 30-36 or Childers CP-50AMV1 lagging adhesive.
3. Do not apply insulation to equipment while hot.
4. The Contractor shall have the option of using 2" thick fiberglass Bend-A-Board insulation with .016" thick aluminum jacket with lock seams at longitudinal seams and 1/2" aluminum bands 12" on center at traverse joints. Joints and jacket shall provide complete protection for the insulation.

H. Heat Exchanger + Converters

1. Cover top and both sides of exchanger with 24 gauge galvanized steel panels with ½" flexible unicellular insulation cemented to the inside of the panels.
2. Panels shall be easily removable and easy to re-install.
3. Adhere flexible unicellular insulation to end plates with Armstrong No. 520 adhesive.
4. Insulate with 2" thick fiberglass, 3# density U.L. Labeled insulation and hexagonal mesh wire screen finished with glass jacket adhered and coated with two coats of Foster 30-36 or Childers CP-50AMV1 lagging adheasive. Flanges shall be treated as specified under Hot Pipe Insulation "Fittings, Valves & Flanges 4" and Larger".
5. The Contractor shall have the option of using 2" thick fiberglass Bend-A-Board insulation with .016" thick aluminum jacket with lock seams at longitudinal seams and 1/2" aluminum bands 12" on center at traverse joints. Joints and jacket shall provide complete protected for the insulation.

I. Cold Equipment (At or below ambient equipment):

1. Includes geothermal/condenser equipment such as air release tanks, air separators, expansion tanks, flash tanks, vessels, etc.
2. Insulate air release tanks (air separators) with 2 inches of pipe and tank insulation or 1½ inches of rigid fiber glass board.
3. Vapor barrier to be provided on geothermal/condenser water expansion tank, air separator and chemical treatment tank.
4. The Contractor shall have the option of using 2" thick fiberglass Bend-A-Board insulation with .016" thick aluminum jacket with lock seams at longitudinal seams and 1/2" aluminum bands 12" on center at traverse joints. Joints and jacket shall provide complete protection for the insulation.

J. Return Air Fans for Air Conditioning Systems:

1. Insulation for single inlet return air fans shall be of material as specified for concealed ductwork and shall be covered with glass cloth or all service jacket smoothly adhered with Foster 85-60 or Childers CP-127 adhesive. Seal joints with 5" wide tape. The Contractor shall have the option to use the following material: Insulation for the fans shall be of thickness noted above and shall be fiberglass Bend-A-Board having a factory applied fire retardant vapor barrier jacket and shall be provided with presized glass cloth smoothly adhered with same adhesive. Bend-A-Board is a 3.00 p.c.f. board cut into strips, adhered to jacketing. Finish shall be Manville No. 301 Insulating Cement or approved equal applied 1/4" thick in one coat, trowelled to a smooth finish. Same option shall apply.

K. Filters:

1. Prefilter, afterfilter housing and flow measuring devices shall be insulated same as ductwork.

L. Exterior Ductwork:

1. Ductwork outside of the building shall have weatherproof cover. Fan located inside or outside of the building shall have insulation similar to return air fans. If fan located outside of the building, provide weatherproofing.
2. Outside Air Intakes and Exterior Ducts: 2-inch thick rigid, fiberglass board, 6.0 pounds per cubic foot density, to a minimum R-value of 8, complete with insulation faced and anchored as described for exposed ductwork.

M. Insulate equipment to match adjoining piping insulation.

N. Outside Air Intakes and Exterior Ducts: 2-inch thick rigid, fiberglass board, 6.0 pounds per cubic foot density, to a minimum R-value of 8, complete with insulation faced and anchored as described for exposed ductwork.

3.7 FIRE RATED DUCT WRAP

A. Remove dirt and dust and clean all duct surfaces.

B. Install per manufacturers instructions and referenced standards. Where pins are required they shall be tack welded to duct.

C. Repair any damage in accordance with manufacturer’s instruction.

3.8 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily. Including units with vapor barrier damage and moisture saturation. The insulation installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 23 08 00

HVAC SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: The Work of this Section shall include but not be limited to the following:

1. Systems and equipment Start-Up and Functional Performance Testing.
2. Validation of proper and thorough installation of Division 23 systems and equipment.
3. Generic Start-Up Documentation for mechanical systems and equipment.
4. Development of final Start-Up Documentation for mechanical systems and equipment.
5. System Start-Up and Turn-Over procedures.
6. Systems balancing verification.
7. Coordination and execution of Training Events.

B. Related Sections

1. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.
2. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.3 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 01 91 00 and Section 01 91 10 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

E. This specification covers the start-up, operating performance test and commissioning of the HVAC systems. The purpose of this effort is to bring the project mechanical systems to a state of dynamic operation in accordance with the contract documents by verifying the operation of individual components, subsystems and systems.

F. The Owner will retain the services of an independent commissioning agent (CA) separate from the work of this Contract. As herein specified the Owner and CA shall develop detailed commissioning procedures, equipment checkout procedures and data forms for recording compliance with contract documents, performance and punchlist deficiencies, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

G. Each Contractor and the General Contractor shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to accomplish the work and labor and material for execution, monitoring and printing data forms necessary to verify and record system observations.

H. The Test and Balance Contractors shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to execute and accomplish the work.

I. At the completion of the start-up, operations performance test and test and balance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner/Architect/Engineer and CA.

1.4 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

B. Mechanical/HVAC Systems: All Division 23 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices (sensors, valves, etc.) that make up these systems are included.

1. Rooftop Air Handling Unit Systems:
    a. Coil entering and leaving air temperature.
    b. Coil entering and leaving water temperature.
    c. Coil water pressure drop.
    d. Space temperatures at thermostats or sensors.
    e. Total fan air CFM.
    f. Selected air flow readings at major branch ducts and grilles.
    g. Fan speed.
    h. Fan total static pressure.
2. VAV System:
    a. Box entering air temperature.
    b. Space temperature at thermostats or sensors.
    c. Total box air CFM minimum position and maximum position.
    d. Selected air flow readings at branch ducts and grilles.
    e. Static pressure entering and leaving box.
3. Fan Powered Systems:
    a. Coil entering and leaving air temperature.
    b. Coil entering and leaving water temperature.
    c. Space temperatures at thermostats or sensors.
    d. Total fan air CFM.
    e. Selected air flow readings at major branch ducts and grilles.
    f. Fan speed.
    g. Fan total static pressure.
4. Ventilation/Outside Air Fans:
    a. Total fan CFM.
    b. Fan speed.
    c. Fan total static pressure.

5. Exhaust Fans:
   a. Total fan CFM.
   b. Fan speed.
   c. Fan total static pressure.
6. Coils (electric):
   a. Input Kw
   b. Entering and leaving air temperature.
7. Heat Exchangers:
   a. Entering water temperature and pressure.
   b. Leaving water temperature and pressure.
8. Electric Motors:
   a. Full load amperes and voltage.
   b. Starter heater size and rated amperage range for heater installed.
   c. Measure running current, after adjustment of system to deliver rated performance.
9. Controls:
   a. Operational setting of controllers and instruments.
   b. Positioning and function of valves and dampers.
   c. Interlock and operation of systems (HVAC and Fire)
10. Refrigeration System:
   a. Compressor safety and operating controls.
   b. Capacity reduction controls.
   c. Low ambient controls.
   d. Condenser fan operation.
11. Pumps:
   a. Water pressure entering and leaving.
   b. Installed impeller diameter.
12. Heat Pumps:
   a. EAT and LAT temperatures on each coil.
13. Heat Recovery Systems
   a. Entering and leaving temperature.

C. Building Automation Systems (BAS)

1. The entire BAS shall be subject to commissioning, including all hardware components, software, networking, programming and engineering services, and controls documentation.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section 01 91 00. In addition, Contractor shall also provide to the CxA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to the Acceptance Phase. Factory Test Reports should be provided in PDF electronic format. These may include but are not limited to:

   a. Rooftop Air Handling Units

   b. Heat Pumps

c. Fans Capacity

d. Fan Sound Power Levels

e. Pump Capacity

2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:

a. Pipe Pressure Testing

b. Duct Leakage Testing

c. Water Treatment

3. TAB Plan: The Testing, Adjusting, and Balancing Plan shall include the following:

a. Certifications on all instruments to be used throughout the testing. Certification must be documented within the previous 6 months.

b. Résumés and Certification of individuals who will be balancing the systems.

c. Detailed step-by-step plans for each procedure to be performed by the TAB Contractor.

d. Sample forms to be used for each measurement.

e. Sample balancing report.

4. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide this document in accordance with details in this Section. CxA will review.

5. Temporary Operating and Conditioning Plan: Contractor shall provide in accordance with details in this Section. CxA will review.

6. Completed TAB Reports. CxA will review prior to FPT.

1.8 SEQUENCING AND SCHEDULING

A. Refer to Section 01 91 00.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CxA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 23.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.

2. Provide factory-trained and authorized technicians where required by the Contract Documents.

3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer’s application, installation and start-up information.

4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-Up, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 01 09 00. Each task or item shall be indicated with the Party actually performing the task or procedure.
8. TAB: As outlined in Section 23 05 93. Specifically as it relates to Cx:
    a. Attend Construction Phase Cx Kick-Off Meeting and Cx progress meetings beginning within 3 months of start of TAB work;
    b. Submit TAB Plan as indicated above;
    c. Meet with Cx team to review TAB procedures and documentation required;
    d. Demonstrate TAB procedures for repetitive tasks (zone balancing, AHU adjusting) as called for by the CxA;
    e. Participate in Action List dialogue;
    f. Provide all documentation electronically.

C. Acceptance Phase
1. Assist CxA in Functional Performance Testing. Assistance will typically include the following:
    a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 01 91 00, Section 01 91 10, and the Cx Plan; in some cases this will entail only an initial sample);
    b. Provide any specialized instrumentation necessary for Functional Performance Testing;
    c. Manipulate BAS and other control systems to facilitate Functional Performance Testing (as specified in Section 01 91 00, Section 01 91 10, and the Cx Plan; in some cases this will entail only an initial sample);
    d. Provide a TAB technician to work at the direction of CxA for up to 8 hours beyond assistance specified above.
    e. Provide a BAS technician to work at the direction of CxA for up to 16 hours beyond assistance specified above.

D. Warranty Phase
1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.
2. Provide representative for off-season testing as required by CxA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION

A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA

A. Refer to Section 01 91 00.

1.15 PIPING CLEANING, FLUSH, AND FILL PLAN

A. Contractors shall provide a “Piping Cleaning, Flush, and Fill Plan” to the CxA that provides a descriptive narrative and supporting calculations of the means and methods that will be used to clean out, flush, and fill the piping systems. CxA will review and post the final approved document to the Portal.

B. The “Piping Cleaning, Flush, and Fill Plan” shall incorporate and be inclusive of all requirements of individual Sections relating to piping and pipe cleaning and flushing. In addition to the requirements of any other related Section, this document shall consist of the following at a minimum for each individual hydronic loop:

1. Overview schematic diagram of each of the hydronic systems, showing individual flow components such as chillers, boilers, pumps, heat exchangers, cooling towers, control valves, and strainers.
2. Narrative and illustration indicating the equipment that will either participate or be bypassed by fluid flow during the clean and flush process.
3. For equipment to be bypassed, description of the means for providing the bypass, including the type, size, and length of hoses or piping to be used.
4. Description of how flow is to be induced (permanent pumps, temporary pumps, etc.) and flow rates to be imposed during the flush process.
5. Calculation of resultant flow velocities in various portions of the piping system, with specific identification of the minimum velocity sections of the piping loop. Velocities should generally be shown to be above a 7 feet-per-second minimum speed to provide for adequate capability to flush and carry debris through the system to the appropriate strainer or clean-out location.
6. Description of cleaning methods and materials to be used to flush the system. Description shall include cleaning material and concentration, details of the cleaning process including duration of circulation and flushing intervals, criteria for determining a “clean” flush, and name and qualifications of cleaning or chemical treatment subcontractors to be used.
7. Identification and discussion of any isolated sections or ‘dead-legs’ that will be present, including means to provide cleaning and flushing for these sections.
8. Details of the strainers to be used for the flush and clean process, as well as final strainers to be used after cleaning. Contractor shall clean all strainers prior to turning over the system for commissioning.
9. If the cleaning and flushing process is to be phased in sections, details should be provided to clarify how clean sections will be protected as other sections are flushed.

1.16 TEMPORARY OPERATION AND CONDITIONING PLAN

A. Contractor shall be allowed to use permanent building equipment to provide temporary conditioning ONLY upon the approval of the A/E, Owner, and the CxA. Approval for such will only be given upon acceptance of a detailed TemGC. This Temporary Operating and Conditioning Plan shall be a required element of the Construction IAQ Management Plan required for the LEED Credit EQ 3.1. The Temporary Operating and Conditioning Plan shall consider/address the following at a minimum:

1. Indicate that the full Start-Up protocol, including development and documentation of Start-Up Documentation as required by the specification will be performed for the temporary start-up. The Temporary Conditioning Plan shall include the Start-Up Documentation to be used, which shall be the same as those that will be used for final Start-Up.

2. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address:
   a. Temporary Filtering of Air: Air filters used for construction shall be as or more effective than those specified for permanent use. Contractor shall remove construction filters and replace with new filters prior to FPT. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a magnehelic gauge for visual indication of pressure drop as well as setting and adjusting the loaded filter DP switch for monitoring on the BAS.
   b. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Construction strainer shall be finer than that specified for final strainers.
   c. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Return or exhaust systems shall not be used during construction unless otherwise approved.
   d. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer's instructions. Contractor shall coordinate lubricants used with Owner's operators. Frequency of lubrication and inspection shall be as recommended by manufacturer's literature. Applicable maintenance lubrication schedules shall be included in the Plan. Draft maintenance logs shall be submitted with Plan and completed as maintenance is performed.
   e. Operation Outside of Normal Ranges: Systems and equipment shall not be operated outside the range of specified conditions. The Temporary Conditioning Plan shall address how the Contractor will ensure that operation will not harm the equipment.
   f. Emergency Condition Identification and Response Protocols: The Temporary Conditioning Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safeties and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is an automatic communication/enunciation medium such as a phone connection or an Internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the Contractor's 24 hour monitoring service and to the Owners help desk. The Contractor shall respond to and be responsible for securing conditions within the building. Owner shall assess the situation and as necessary secure utilities feeding the building from isolation points outside of the building.

3. Campus Utility Impact: The Temporary Conditioning Plan shall address the expected impact on the campus utilities involved in the temporary conditioning equipment. Specifically address:
   a. How the systems will be controlled to both ensure they are operating in range, and to avoid energy waste or inefficient conditions;
   b. Project the range of loads and flows to be imposed on the campus systems. For cooling, indicated how you will ensure a temperature split of at least 12°F.
   c. For campus chilled water connections, the bridge connection and automatic control of the bridge-related sequences shall be installed, functional and tested.
4. Building Protection: Address how the system will be controlled to avoid humidity conditions that could either promote mold growth or cause corrosion.

5. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be reconditioned to like-new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.
6. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned prior to Turn-Over.
7. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Owner on a frequency specified by the Owner.
8. Operating System Alterations: The Temporary Conditioning Plan shall address specific protocol for doing work on the systems.
9. Damages: Any material, device, component, or equipment that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the Contractor at no cost to the Owner or to the project.
10. Segregation: Where only portions of a system are to be used, Contractor shall specifically indicate how the used portion will be isolated from the unused portion. The Temporary Conditioning Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

1.17 TRAINING EVENTS AND TRAINING PLAN

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS

A. Refer to Section 01 91 00 the individual Specifications.

1.19 BAS TRENDING REQUIREMENTS

A. Trending requirements are as specified in Section 01 91 00 and Section 230801

B. The BAS Contractor shall configure and analyze all trends required under Section 230801.

C. Trends are historical archives on computer disks that document the operation of the systems and equipment. Trends can be time-series (interval) recordings of system I/O parameters or change-of-value (COV) based trends that record when a system value changes by more than a specified threshold.

D. CxA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CxA.

E. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same time intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis.. Data shall be forwarded in one of the following formats.
   1. Microsoft Access Database (.mdb)
   2. Microsoft Excel Spreadsheet (.xls)
   3. Comma Separated Value (.csv or .txt), preferably with quotes delimiting text fields and # delimiting date/time fields.

F. Sample times indicated as COV (±) mean that the changed parameter only needs to be recorded whenever the value changes by the amount listed. When output to the trend file, the latest recorded value shall be listed along with the

time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the time interval common to other point trends for the system.

G. Contractor shall provide the CxA with required passwords, phone numbers, etc. to allow the CxA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.

1.20 FUNCTIONAL PERFORMANCE TESTING

A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.21 FPT ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will typically be that specified with the individual system, equipment, component, or device.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

B. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1°F.

C. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

D. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

E. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CxA.

F. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 01 91 00 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 SYSTEM COMMISSIONING

A. All systems components, equipment, etc. furnished as part of this Contract shall be subjected to system commissioning as hereinafter specified. All systems, components, equipment, etc. commissioned in this section of the Specifications shall be evaluated based on the sequences of control/operation, performance characteristics, and equipment schedules, etc. as specified in other sections of the Specifications and as shown on the contract drawings. Systems, components, equipment, etc. that does not have specified operating sequence, etc. shall be operated and evaluated based on its use and function for this project.

B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in 3-ring binders. The commissioning documentation shall be organized by system when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Design Criteria provided by the A/E.
2. Approved Test and Balance Report for the system or component being commissioned, provided by Test and Balance Contractor.
3. Approved submittals for all equipment to be commissioned, provided by Mechanical Contractor.
4. All approved shop drawings of equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders. Provided by Mechanical Contractor.
5. All pre-commissioning checklists initialized by indicated personnel organized by system and subsystem.
6. All functional performance test checklist initialized by indicated personnel organized by systems and subsystems.
7. Three copies of the Operation and Maintenance Manuals specified in other sections of these specifications shall be reviewed by the CA for completeness and for applicability. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

C. Shop Drawings and As-Built Drawings and Specifications shall be assembled by the Contractor after completion of the pre-commissioning phase and turned over to the Owner's representative. Changes as a result of subsequent Commissioning procedures will be incorporated (as required) at the conclusion of final Commissioning.

D. Commissioning Schedule:

1. Phase 1 - Preliminary Commissioning: All shop drawings, including but not limited to, equipment, controls, test and balance reports, and operation and maintenance manuals, shall be submitted and approved by the CA. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).
2. Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete. Owner's operation and maintenance personnel shall observe the function performance testing. The Contractor may perform initial system familiarization and training of Owner's operating and maintenance personnel required under other sections of the Specification during the functional performance testing.
3. Functional Performance Test Notification: The Contractor shall notify the CA 2 weeks before functional performance testing is to begin.
4. Phase 3 - System training and operating instructions shall be conducted by the Contractor as indicated in the specifications of each item of equipment. The Contractor shall be responsible for specified training and operating instructions being observed by the CA.

E. Pre-Commissioning Checklists:

1. Pre-Commissioning Checklists shall be developed by the CA and shall be executed and certified prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contractor shall provide the CA with the completed Pre-Commissioning Checklists for his review and initials. The CA shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of any pre-commissioning activities of any systems or equipment. Representatives may be replaced only after written approval from the CA.
2. Initials Legend:
   a. Construction Manager.
   b. Mechanical Contractor's representative.
   c. Electrical Contractor's representative.
   d. Commissioning Agent.
   e. Balancing Contractor's representative.
   f. Controls Contractor's representative.
3. Pre-Commissioning checklists shall be provided for each system and piece of HVAC equipment to be Commissioned. Checklists shall be submitted to the Architect and Owner to review.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by the Contractor as directed by the CA and observed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all contractor and subcontractor representatives responsible for the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to the commencement of functional performance testing of systems and equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.
2. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the CA listing the deficiencies causing the failure and remedies to correct all deficiencies. After the

Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.

3. Failure to complete 2 functional performance test checklists constitutes failure of Phase 2 of the HVAC Commissioning process. The Contractor shall provide a written report to the CA listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, Phase 2 of the HVAC Commissioning process shall be repeated in its entirety. The Contractor shall give the CA 2 weeks notice before repeat functional performance testing is scheduled. Should the first or one subsequent functional performance test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to perform more than two (2) functional performance tests.
4. Blank examples functional performance test checklists are in the Appendix 2 located at the end of this section of the specifications. A separate Functional Performance Checklist shall be provided for each system and piece of equipment to be Commissioned.

3.3 DEMONSTRATION TEST

A. After completion of system start-up, operating performance test and commissioning, but before Owner acceptance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems provided under this Contract. The intent of the 72 hour dynamic test is to verify that the mechanical and electrical equipment will respond as designed to meet the changes that may occur under varying indoor/outdoor conditions including seasonal variations and occupancy loads.

B. A detailed procedure and sequence of events shall be developed by the Contractor and submitted to the Owner and CA for review and approval. Procedures and sequence of events should contain as a minimum the following activities:

1. Hours 1-4: Bring all systems on line for standard operations and parameters.
2. Hours 5-28: Operate all systems under normal parameters and verify proper operation.
3. Hours 29-52: Validation of systems operation through indoor/outdoor changes to include heating, cooling, ventilation, humidity control and control systems.
4. Hours 53-72: Return of systems to normal operation.

C. Systems and their associated equipment which are to be included in the dynamic test are all systems and components furnished under this Contract and as a minimum will include, but are not limited to the following:

1. Pressurization Air Handling Systems
2. Air Handling Systems
3. Geothermal/Condenser Water Systems
4. Solar Thermal System
5. Heat pump Systems
6. Pumping Systems
7. Exhaust Systems
8. Air Filtration Systems
9. Building Management and Control Systems

D. Contractor shall notify the Owner and CA in writing that the project is completed and ready for the demonstration test. Schedule for test will then be established and documented. Initiation of the 72 hours dynamic test will not occur until all systems are balanced, operational and incorporated into the building management and control system.

Should the demonstration test fail for any reason, the problems shall be corrected and another demonstration test conducted. Should the first or one subsequent demonstration test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to witness more than two (2) 72 hour demonstration tests.

E. The attendees of each 72 hour demonstration test shall include representative from the following organizations:

1. General Contractor
2. Mechanical Contractor
3. Electrical Contractor
4. Test and Balance Contractor
5. Building Management and Control System Contractor
6. Architect of Record
7. Mechanical Engineer
8. Electrical Engineer
9. Commissioning Agent

Minor problems are anticipated and the necessary personnel required to correct problems and adjust systems need to be available to insure continuation of the dynamic testing process. Is major problems are encountered, at the discretion of the Owner and CA, the testing will be terminated and rescheduled.

The Contractor shall notify any external organizations, which are not directly involved in the testing, but might be affected due to interface to insure that false alarms do not occur.

F. During the demonstration test all systems shall operate in the “hands-off” automatic mode in accordance with the requirements of the Contract Documents. Changes in operating modes required to simulate load shifting, seasonal changeover, emergency modes, etc. will be accomplished by changing set points and equipment operating status at the BMS central control console as required to observe capacity control and monitoring. Provide a readout of space temperature at each thermostat, building relative humidity, building pressurization, chilled water supply and return temperatures, chiller capacity and other critical measurements.

3.4 START-UP DOCUMENTION COMMON TO ALL SYSTEMS

A. The following Start-Up Documentation (Checklists and Tests) shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer’s recommendations.
6. Verify system has undergone Start-Up per the manufacturer’s recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all gauges and test ports are provided as required by contract documents and manufacturer’s recommendations.
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all rotating and moving parts are properly lubricated.
15. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.5 VALVES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
2. Verify actuators are properly installed with adequate clearance.
3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
5. For electronically operated valves, check the stroke and range.
6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.6 METERS AND GAUGES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Adjust faces of meters and gauges to proper angle for best visibility.
2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.7 MECHANICAL IDENTIFICATION

A. Start-Up Checks: Perform the following checks:

1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.8 MECHANICAL INSULATION

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.

1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
2. Ensure the integrity of vapor barrier around all cold surfaces.

3.9 PIPING - GENERAL

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: These procedures apply to all installed piping systems, including underground site utilities.

1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
4. Provide notification of pipe cleaning and flushing activities.
5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
6. Ensure adequate drainage is provided at low points and venting is provided at high points.
7. Ensure facilities to effectively drain and fill the system are in place.
8. Ensure air is thoroughly removed from the system as applicable.
9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
10. Provide notification of pressure testing.
11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
13. Submit pressure test reports that document the pressure testing results with certification of the results.
14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
15. Set and adjust fill, pressure, or level controls to the required setting.

3.10 AC MOTORS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Verify proper alignment, installation, and rotation.
2. Verify properly sized overloads are in place

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Measure insulation resistance, phase balance, and resistance to ground.
2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
3. Record all motor nameplate data.

3.11 BEARINGS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions. This applies to all bearings on fans, pumps, compressors, and other equipment installed under this Division.

1. Check alignment as applicable.
2. Lubricate all bearings per the manufacturer's instructions. When bearing is used for temporary conditioning, lubricate on manufacturer's recommended frequency and document it.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer's recommendations.
2. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak-to-peak acceleration. Compare it to the Vibration Severity Chart. Rectify any condition causing severity indicated as "Rough" or worse.

3.12 VARIABLE SPEED DRIVES

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide start-up service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Check unit for shipping damage.
2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field-installed wiring.
3. Check for proper torque on connections.
4. Verify use of shielded cable where specified and check that shields have been terminated properly.
5. Verify grounding.
6. Check motor nameplate against drive input rating.
7. Manually rotate motor shaft to ensure free rotation.
8. Check that motor leads are not grounded.

D. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions. Ensure device and system which drive is serving is configured to withstand the device operation specified below.

1. Adjust the 'Minimum Voltage Adjustment' to enable starting but not to draw excessive power at start.
2. Adjust the 'Volts/Hz Adjustment' to proper setting.
3. Adjust the 'Acceleration and Deceleration Rates' to the specified times.
4. Adjust 'Current Limiting' to coordinate with the overcorrect device and protect the motor.
5. Set the 'Maximum and Minimum Speed' pots.
6. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
7. Determine any critical speeds to avoid and set these in the drive.
8. Check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.
9. Measure and record overall efficiency at 50%, 75%, and 100%.
10. Record the motor terminal voltage.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance. Review data in manufacturer's Operation and Maintenance Manuals.

3.13 HYDRONIC PIPING

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:

1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1.
2. Flush system with clean water in accordance with applicable Section.
3. Clean strainers.
4. Check expansion tanks to determine that they are not air-bound and that the system is completely full of water.
5. Set automatic fill valves for required system pressure.
6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
7. Set and coordinate automatic fill pressure and relief valve settings.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.14 PUMPS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Refer to 'AC Motors' in this Section.

C. Refer to 'Bearings' in this Section.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

E. Start-Up Checks: Perform the following checks during start-up:

1. Check suction lines connections for tightness to avoid drawing air into the pump.
2. Clean and lubricate all bearings.
3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
5. Clean associated strainers.
6. Check that the proper overloads have been installed in the starter and are the correct size.
7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
8. Align pump within manufacturers recommended tolerances.
9. Ensure all associated piping has been cleaned, tested, and deaerated.
10. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

F. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Start the pump per the manufacturer's instructions.
2. Check the general mechanical operation of the pump and motor.
3. Verify that checkvalve seal is appropriate.
4. Check noise and vibration levels and ensure they are within the manufacturer's recommended tolerances.
5. Check that the NPSH is with that allowable for the operating condition.
6. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.15 PACKAGED HEATING AND COOLING UNITS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. Refer to AC Motors in this section.

D. Start-Up Checks: Perform the following inspections/checks during start-up:

1. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
2. Install new filters after start-up.

E. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals.

3.16 ROOFTOP HEATING AND COOLING UNITS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. Refer to AC Motors in this section.

D. Start-Up Checks: Perform the following inspections/checks during start-up:

1. Ensure unit is level.
2. Coils are undamaged and fins are combed.
3. Condenser fan rotates freely and check rotation direction.

E. Start-Up Tests: Perform the following before or during start-up:

1. Start-up condensing units, in accordance with manufacturer's start-up instructions.
2. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
3. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.
4. Install new filters after start-up.

F. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals.

3.17 TERMINAL UNITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following inspections/checks during start-up:

1. After construction is completed, including painting if applicable, clean unit exposed surfaces.
2. Vacuum-clean terminal coils and inside of cabinets.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
4. Verify adequate access for maintenance.
5. Check power and control voltages.
6. Check rotation of fan where applicable.
7. Check calibration and operation of the controlling elements.
8. Check control valves for required close-off and fail position.
9. Install new filter units for terminals requiring same.

3.18 VAV TERMINAL UNITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to and coordinate with Division 23 Section "Testing, Adjusting, and Balancing".

C. Start-Up Checks: Perform the following inspections/checks during start-up:
1. After construction is completed, including painting if applicable, clean exposed unit surfaces.
2. Clean factory-finished surfaces. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
4. Ensure that air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.
5. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.
6. Ensure the coils are undamaged, combed, and vented.
7. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly.

D. Start-Up Tests: Perform the following during start-up:

1. Calibrate and adjust the airflow control parameters. Set applicable min and max setpoints. Coordinate with the ATC contractor as necessary to obtain flow parameters required.
2. Install new filters where required.
3. Set all temperature and humidity setpoints to those as directed by Owner.
4. Record supply air temperature at full cooling and at full heating (compare both with current air handler temp)

3.19 FANS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. References: The following additional Sections shall also apply:

1. Refer to AC Motors in this Section.
2. Refer to Bearings in this Section
3. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
4. Refer to Division 23 Section “BAS Commissioning” for procedures for starting the controls related to the AHU.

D. Start-Up Checks: Perform the following inspections/checks during start-up:

1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. Verify that unit is secure on mountings and supporting devices and connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
5. Ensure vibration isolation integrity is maintained with the fan installation and associated connections.
6. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
8. Stroke all dampers to ensure free and full travel.

E. Training: Contractor shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer’s Operating and Maintenance Manuals.

3.20 ENERGY RECOVERY VENTILATION SYSTEMS (WHEEL-BASED)

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to AC Motors in this Section.

C. Refer to Fans in this Section (if applicable).

D. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

E. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's start-up instructions:

1. Check for damage to the ERV wheel and media and ensure media is evenly/thoroughly impregnated.
2. Ensure the ERV wheel rotates freely.

3. Ensure all drive components are correctly installed, aligned and lubricated.
4. Ensure air seals are tight and properly installed.
5. Verify all controls are in place and that they are properly interfaced.

F. Start-Up Tests: Follow the manufacturer's written procedures and the following as a minimum:

1. Energize circuits.
2. Check for proper rotation in all modes of operation.
3. Start and run ERV unit through complete sequence of operations.
4. Measure and record the sensible and latent recovery efficiency.
5. Measure and record air pressure drop.
6. Adjust operating controls.

G. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer’s Operating and Maintenance Manuals.

3.21 AIR CLEANING AND FILTERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with re-testing.

3.22 METAL DUCTWORK

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure using polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

C. Start-Up Checks: Perform the following checks during start-up and as specified:

1. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
2. Strip protective paper from stainless ductwork surfaces if applicable, and repair finish wherever it has been damaged.

D. Start-Up Tests: In addition to specifications, perform the following as a minimum:

1. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.
2. Balancing: Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.23 DUCTWORK ACCESSORIES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified:

1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Start-Up Tests: In addition to specifications, perform the following as a minimum:

1. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.
2. Label access doors in accordance with Division 23 Section "Mechanical Identification".
3. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
4. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing".
5. Fire Damper Testing: For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

3.24 AIR TERMINALS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Upon completion of installation and prior to initial operation, check that air terminals are:

1. Properly installed with the proper airflow direction.
2. Properly supported with vibration isolation integrity maintained where applicable.
3. Duct connections to air terminals are leak-tight.
4. Operable dampers travel free.
5. Airflow measuring devices are properly installed and connected.
6. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
7. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

3.25 BUILDING AUTOMATION AND CONTROL SYSTEMS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified:

1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Start-Up Tests: Refer to Section 230801 “BAS Commissioning”. This requires manufacturers authorized representative to start-up, test, adjust, and calibrate direct digital and other microprocessor-based control systems and demonstrate compliance with requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

3.26 TESTING, ADJUSTING, AND BALANCING

A. Reference: Perform testing, adjusting, and balancing (TAB) procedures on each system identified, in accordance with the detailed procedures outlined in the respective section and the referenced standards.

B. Start-Up Checks: In addition to specifications, perform the following as a minimum:

1. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
2. Patch insulation, ductwork, and housings, using materials identical to those removed.
3. Seal ducts and piping, and test for and repair leaks.
4. Seal insulation to re-establish integrity of the vapor barrier.
5. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
6. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
7. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Training:

1. Train the Owner's maintenance personnel on troubleshooting procedures and on testing, adjusting, and balancing procedures.
2. Review for the Owner’s personnel the locations of TAB reports and data.

3.27 ROOM/ZONE CHECKOUT

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Contractor shall complete a checklist acknowledging completion of Div. 23 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

C. Typical Room:

1. Diffusers, registers, and grilles installed and cleaned.
2. Zone controls in place and functional.
3. All terminal equipment functional, clean, and punched out.
4. Occupancy schedules entered with applicable control setpoints.

D. Rooms with Plumbing Fixtures

1. Plumbing fixtures clean and operational.

3.28 HEAT TRACING

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Electrician shall measure insulation resistance of heater with 1000 volt DC megohmeter (megger) after the plumber has attached heater to pipe and before thermal insulation has been installed. Insulation resistance, measured between braid and either bus wire, should be at least 20 megohms regardless of heater length. Record these readings for each circuit.

C. Contractor shall test continuity of both heater bus wires to verify connection of splices or tees.

D. Megger heater after thermal insulation has been installed and record readings. Insulation resistance should be at least 20 megohms when measured at 1000 volts DC.

E. If heater circuit fails either insulation resistance test or continuity test, electrician shall notify Plumbing Contractor. Plumbing Contractor must repair or replace circuits yielding unacceptable readings. Megger tests must be witnessed by Construction Manager and manufacturer's representative. Copy of test report shall be submitted to engineer. Manufacturer's representative shall retain one copy for their file and mail copy to factory for record.

3.29 SEQUENCING ILLUSTRATION

A. Reference Section 01 91 00.

END OF SECTION

SECTION 23 08 01

BUILDING AUTOMATION SYSTEM (BAS) COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: The Work of this Section shall include but not be limited to the following:

1. BAS Start-Up and Functional Performance Testing.
2. Validation of proper and thorough installation of BAS and associated equipment.
3. Generic Start-Up Documentation for BAS.
4. Development of final Start-Up Documentation for BAS.
5. Functional Performance Testing of BAS.
6. Coordination of BAS-related training.
7. Documentation of BAS Operation and Maintenance Documentation.

B. Related Work and Documents

1. The Cx process references many related Sections.
2. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.3 GENERAL DESCRIPTION

A. This section defines responsibilities of the Building Automation System Contractor to commission the BAS.

B. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

C. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

D. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

1.4 SCOPE

A. The scope of Commissioning on this project shall include the entire BAS system.

1.5 DEFINITIONS AND ABBREVIATIONS

A. POT (Portable Operators Terminal): Portable operator workstation (typically a laptop computer) that has BAS software loaded and the capability to access, program, and edit the BAS.

B. HHD (Hand-Held Device): Portable device (typically with limited functionality) that is used to access components of the BAS. May be a standard PDA or proprietary device/interface.

1.6 CONTRACTOR RESPONSIBILITIES

A. General responsibilities of the BAS Contractor (BAC) are specified in Section 01 91 00. The following indicate additional specific responsibilities of the BAS Contractor.

B. Assist CxA in verification and Functional Performance Testing. Assistance will typically include the following:

1. Establish trend logs of system operation as specified herein.
2. Manipulate systems and equipment to facilitate Functional Performance Testing. Typically, this will only be for initial samples of like systems.
3. Provide POTs or operator workstations in locations convenient to testing activities as specified below.
4. Provide CxA with appropriate passwords, keys, and access to control panels and workstations.
5. Where control systems do not allow a test mode or the overriding of physical input values for testing, program an interim virtual point for all inputs that can be used to represent the point and be overridden for testing.

C. Provide a control technician to work at the direction of the CxA for software optimization assistance for a minimum of 16 hours during the Acceptance Phase of the project.

D. Controls Parameter Matrix: Contractor shall provide a form summarizing all setpoints and alarm parameters and alarming strategies for the Owner to complete. Organize a meeting to discuss the desired initial setpoints and alarm parameters. Contractor shall enter the requested setpoints and alarm parameters at completion of start-up and record the applicable settings in the Start-Up Documentation.

E. Final Systems Operation Training: The BAC shall train the Owner and Operators on whole-building operation and use of the BAS. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion.

F. Compensate the Owner for any BAS Contractor site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing. All testing failures which require on-site time for retesting will be considered actual damages to the Owner. The contract sum shall be reduced by contract modification at a rate of $160 per worker-hour of on-site time necessary to retest failures. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification.

1.7 COMMISSIONED EQUIPMENT

A. All Air Handlers and as scheduled.

B. All VAV, CAV and FP boxes as scheduled.

C. All pumps as scheduled.

D. All heat pumps as scheduled.

E. All split systems as scheduled.

F. All fans as scheduled.

G. Water Treatment.

H. Heat Exchanger.

1.8 COMMISSIONED SYSTEMS

A. All HVAC systems in new and renovated spaces.

1.9 COMMISSIONING PLAN

A. The CA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.10 COMMISSIONING FORMS

A. Review 100% CD's. Provide written summary of how each commissioned item of equipment, should operate include calculations verifying scheduled capacity.

B. The CA shall develop forms for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and proved by the Owner prior to acceptance. Each form shall be signed by the Contractor, CA and Owner prior to acceptance of a system or piece of equipment.

1.11 SEQUENCING

A. The following list outlines the general sequence of events for Commissioning of the BAS.

1. Construction Phase:
    a. Collaborate on construction scheduling.
    b. Submit Product data and Shop Drawings, and receive approval.
    c. Meet with Cx Team to coordinate with all trades.
    d. Submit Control Logic Documentation, and receive approval.
    e. Begin BAS installation.
    f. Submit refinement of generic Start-Up Documents incorporating manufacture-specific start-up requirements accompanied by manufacturers pre-printed start-up forms for all equipment provided by the BAS Contractor
    g. Receive BAS Start-Up Documents approval from CxA.
    h. Submit Training Plan content.
    i. Receive approval of Training Plan content.
    j. Provide alarm list and receive approval.
    k. Provide sample graphics and receive approval.
    l. Complete BAS installation.
    m. Place systems under BAS control.
    n. Enter alarms as approved by Owner.
    o. Complete BAS graphics.
    p. Perform BAS system start up and complete Start-Up Documentation.
    q. Submit completed BAS Start-Up Documentation.
    r. Prepare and initiate trend log data storage and format trend graphs.
    s. Train Owner on BAS operation and maintenance.
    t. Formal BAS System Turn-Over Meeting.
    u. Submit commissioning BAS Software/Access and provide Level 5 (monitoring, point override/test, and setpoint adjustment) password access to Owner and CxA.

v. Receive BAS Start-Up Documentation approval and approval to schedule BAS demonstration of completeness.

w. Demonstrate systems to CxA and Owner.

x. Submit trend logs in format specified.

y. Receive FPT or BAS demonstration approval and approval to schedule Acceptance Phase.

2. Acceptance Phase

a. Two-week BAS Observation Period to witness stable BAS operation.

b. Receive Observation Period approval which enables start of Functional Performance Testing.

c. CxA performs Functional Performance Testing and BAS Contractor participates in initial samples.

d. Receive Functional Completion approval for the BAS.

3. Substantial Completion.

4. Warranty Phase

a. Provide administrator access password access to Owner.

b. Train Owner on final sequences and modes of operation (Final Systems Operation Training).

c. Update Systems Manual content with any changes.

d. Revise and re-submit record drawings and O&M manuals.

e. Install framed control drawings.

f. Final Completion.

g. Opposite-season operational test and Functional Performance Testing.

h. Receive opposite-season operational test and FPT approval.

i. Revise and re-submit record drawings and O&M manuals.

j. Update framed control drawings.

k. Complete owner training.

l. End of Warranty Period.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1°F.
2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CxA.

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. General: The Cx Portal ('Portal') is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process. The Portal uses a hierarchical object tree to represent building systems, components and devices. From this object tree, one can access associated information at and below the applicable level. All applicable elements of information are associated with the object tree. The Portal facilitates either completing information directly via the software or by printing forms to fill out in the field.

B. Participation: All general and major subcontractors participating in the Cx process shall participate in the use of the Portal to document the Cx procedures.

C. Requirements for Use: Options for accessing and interfacing with the Cx Portal are as follows:

1. Print, Test, and File: Using this approach, Contractors simply go online to the Portal using a web browser, print checklists and tests as needed, fill them out in the field, and enter the results back into the Portal database when completed.
2. Online in the Field: The applicable documents can be accessed and filled out live and online if the Contractor has the means to access the Internet while working in the field using a local Wi-Fi network or wireless air card.
3. Database Client: At the Contractor's option, the CxA can provide the Contractor with a software tool that will allow the Contractor to download electronic test database files from the Portal, work on the database files in the field electronically (but offline), and later synchronize their entries with the master database on the Portal.

D. Portal Training: Included in the contract are two Contractor training sessions given by the CxA (one scheduled near the Construction Phase Cx Kickoff Meeting and one scheduled prior to the first equipment Start-Up). Contractors shall send at least one representative to at least one training session. Each Contractor is entitled to two hours phone technical support beyond training sessions.

2.3 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL

A. Provide the CxA with all software, connection devices, licenses, passwords, etc. to facilitate connection to the BAS throughout the building. Provide a license to graphic software, and all operating software necessary for testing and configuration of all control elements at all levels. License may be a temporary license that will expire after the completion of the Warranty Period. Options include:

1. A laptop computer provided by BAS Contractor for dedicated use by the CxA throughout the Construction and Acceptance Phases. This would be turned over to the Owner at the end of the Acceptance Phase.
2. Browser access to the full graphic software: CxA will provide laptop, however BAS Contractor shall set up the laptop to successfully connect.
3. Licensed client software to be installed on CxA computer: BAS Contractor shall install the software and ensure it is functional.
4. Terminal Services session access to a graphic server with required CALs to allow use of all required software. BAS Contractor shall configure the CxA computer to connect to the terminal session.

B. Access to the BAS must be provided throughout the building as more fully defined as follows:

1. Full wireless connection to the graphic server throughout the building will be adequate.
2. Network connection for full access to the graphic server within 50' of any point in the building.
3. Exception to 1 and 2 above: An acceptable alternative to full building access to the graphic server relating to terminal controls shall be providing to the CxA the devices and software required to connect to local terminal controllers through a connection port in the space such as connection to a jack on the temperature sensor (basically what is required by TAB specified below). This does not apply to mechanical rooms as full graphic access is required in mechanical rooms.

C. Provide software required by TAB to calibrate all flow sensors. TAB will provide computer to be used as a portable operator's terminal. Any manufacturer specific hardware such as connection cables, converters, hand held devices, etc. shall be provided by the BAS Contractor.

D. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor as well as at the box. Otherwise a wireless system shall be provided to facilitate this local functionality.

PART 3 - EXECUTION

3.1 BAS START-UP TESTING, ADJUSTING, CALIBRATION

A. BAS work and/or systems shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:

1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB Contractor to obtain and with CxA to fine tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor, and note any TAB deficiencies in the BAS Start-Up Documentation:
    a. Optimum duct static pressure setpoints for VAV air handling units.
    b. Minimum outside air damper settings for air handling units.
    c. Optimum differential pressure setpoints for variable speed pumping systems.
    d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations. BAS Contractor shall provide hand held device as a minimum to the TAB and CxA to facilitate calibration. Connection for any given device shall be local to the device (i.e., at the VAV box or at the thermostat). HHD or POT shall allow querying and editing of parameters required for proper calibration and Start-Up.
    e. Calibration parameters for fume hoods.
5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start-Up Documentation.
6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:
    a. Check for adequate installation including free travel throughout range and adequate seal.

b. Where control loops are sequenced, check for proper control without overlap

8. For actuators:
   a. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
   b. Check for appropriate fail position, and that the stroke and range is as required and coordinated with the programmed ranges when it is operating under normal conditions.
   c. For pneumatic operators, adjust the operator spring compression as required to achieve close off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device.
   d. Check the stroke and range under actual loading conditions and validate that they correlate with programmed values.
   e. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device.
10. For outputs to reset other manufacturers devices (such as VSDs) and feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved Start-Up Documentation to record results. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start-Up Documentation. Except from a start-up, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any step-change (for which the system has the capability to respond) in the control loop, the following tolerances shall be maintained (exceptions noted):
    a. Duct air temperature: ±1°F
    b. Zone temperature: ±3°F within 3 minutes and control within ±2°F
    c. Chilled water temperatures: ±1°F
    d. Hot water temperatures: ±2°F
    e. Duct air pressure: ± 0.25" w.g.
    f. Water pressure: ±1 psid
    g. Duct relative humidity: ±3% when adding humidity
    h. Zone relative humidity: ±5% when adding humidity
    i. Terminal air flow control: ±5% of setpoint. This includes all VAV terminal control and exhausted BSCs, canopy hoods, ventilated cage racks, necropsy tables, and other scientific equipment with supply or exhaust ventilation.
    j. Fume hoods: ±10% on full sash travel (from min to max in 3 seconds) within 3 seconds. ±5% when sash is positioned in the controllable range. Refer to Section 15995 for fume hood acceptance requirements.
    k. Zone pressurization (on active control systems): ±0.03" w.c. with no door or window movements. No high containment space shall go more than 0.15" w.c. positive, nor go positive at all for more than 20 seconds.
14. For communication interfaces and BAS control panels:
    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.

c. Check power supplies for proper voltage ranges and loading.
d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
e. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
f. Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
g. Ensure that all outputs and devices fail to their proper positions/states.
h. Ensure that buffered and/or volatile information is retained through power outage.
i. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
j. Check for adequate grounding of all BAS panels and devices.
k. Run self-diagnostic routines and ensure they are functional.
l. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.

15. Coordinate desired initial alarm strategies with Owner's Operators. Set all required alarms and document the initial settings in the Start-Up Documentation.

16. Coordinate all initial setpoints with Owner's Operators. Ensure those setpoints are active.

17. For Operator Interfaces:
    a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
    b. Output all specified BAS reports for review and approval.
    c. Verify that the alarm printing and logging is functional and per requirements.
    d. Verify that trend archiving to disk and provide a sample to the CxA for review.
    e. Verify alarm enunciation functionality. Time delay from actual occurrence to the time updated or enunciated on the screen. Ensure it is per the specified requirements.
    f. Verify that real time and historical trends are accessible and viewable in graph format.
    g. Verify that paging/dial out alarm annunciation is functional.
    h. Verify the functionality of remote OIs and that a robust connection can be established consistently.
    i. Verify that required third party software applications required with the bid are installed and are functional.
    j. Demonstrate open protocol and custom third party interfaces reliably communicate and check response time.
    k. Verify response times and screen update and refresh times are per the requirements.
    l. Verify that all custom programs are editable from the OI. Check upload, download, and backup and restore capabilities of system configuration information as well as custom programs.
    m. Verify schedules are set up and working.
    n. Verify Owner stipulated security and permissions is set up and functional.
    o. In concert with the Building Power Outage test, validate that critical GUI installations are properly powered by UPS and emergency outlets to keep it functional during a power outage. Validate that the space has adequate lighting to manage the building in the event of an outage.

18. Start-up and check out control air compressors and air drying and filtering systems in accordance with the appropriate section and with manufacturer's instructions.
    a. Validate adequate deliver and pressures
    b. Validate adequate redundancy
    c. Validate max run time and cycle time vs manufacturer's recommendations

d. Validate that routing of the compressed air does not result in condensation at any point in the system when used with the specified drier

e. Check all PRVs both primary and back up to ensure adequate functionality and maintenance of downstream pressure

19. Verify proper interface with Fire Alarm System.

20. Verify proper interface with control panels of equipment with self-contained controls that are being monitored by the BAS.

B. Submit Start-Up Documentation. This shall be completed, submitted, and approved prior to demonstration and Acceptance Phase.

3.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors Without Transmitters--Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.

2. Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to

3.3 LOOP TUNING

A. For all control loops, Contractor shall tune the loops to ensure the fastest stable response without hunting, offset or overshoot with tolerances defined above. Contractor shall introduce upsets to the load when possible to affect response. Otherwise, setpoints can be changed to affect the response.

B. Generally tune loops during periods of high gain.

C. Document all parameters either by capturing text, short interval trends, or screen shots of trend graph documenting the final response.

3.4 COIL VALVE LEAK CHECK

A. Verify proper close off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via

the OI, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.5 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the OI readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command valve to a few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics)

3.6 ALARM SETPOINT COORDINATION

A. The Contractor shall prepare a list of all conceptual point types and recommend the types and recommended alarming strategies and setpoint for review of CxA and Owner. Owner shall use this alarm list to provide direction to Contractor for alarm strategies and setpoints. Alarm list shall be provided at least two months prior to the first functional test. Contractor shall have alarm setpoints entered prior to functional testing. Omitting an alarm setting, using the wrong strategy, or entering the wrong setpoints will be considered a failure from the perspective of the functional test.

3.7 GRAPHIC COORDINATION

A. The Contractor shall prepare all graphics (only one example graphic is required for typical systems like terminal units) with points embedded for review of CxA and Owner. Owner shall use these graphics to provide direction to Contractor for the required final graphic. All final graphics must be complete and active before functional testing. Any deviation from the approved graphics will be considered a failure from the perspective of the functional test.

3.8 BAS DEMONSTRATION

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the CxA and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the CxA for re-demonstration, Contractor shall reimburse Owner for costs of subsequent CxA site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CxA.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

4. Demonstrate correct calibration of input/output devices using the same methods specified for the start-Up tests. A maximum of 10 percent of I/O points shall be selected at random by CxA and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by CxA for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
5. Demonstrate that all BAS and other software programs exist at respective field panels. The BAS programming and point database shall be as submitted and approved.
6. Demonstrate that all BAS programs accomplish the specified sequences of operation.
7. Demonstrate that the panels automatically recover from power failures, as specified.
8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
9. Identify access to equipment selected by CxA. Demonstrate that access is sufficient to perform required maintenance.
10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Functional Performance Testing. CxA shall determine if the system is ready for Functional Performance Testing and document any problems requiring Contractor attention.

1. If the systems are not ready for Functional Performance Testing, Contractor shall correct problems and provide notification to the Owner's representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one week period. This process shall be repeated until CxA issues notice that the BAS is ready for Functional Performance Testing.

F. Any tests successfully completed during the BAS Demonstration will be recorded as 'Passed' for the Functional Performance Testing and will not have to be re-accomplished.

3.9 BAS ACCEPTANCE PHASE AND OBSERVATION PERIOD

A. BAS Acceptance Phase: BAS Acceptance Phase consists of the Functional Performance Testing process of the BAS by the CxA and shall begin after approval of the BAS Demonstration and prior to issuance of Substantial Completion. Acceptance Phase for the BAS shall not be scheduled until all HVAC systems are in operation, the Start-Up Documentation has been reviewed, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, etc.), and TAB report has been submitted and approved. Acceptance Phase and its approval to begin will be performed on a system-by-system basis if mutually agreed upon by Contractor and Owner.

B. BAS Observation Period: After Functional Performance Testing, the BAS shall be shown to operate properly for 2 weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, BAS Contractor shall forward the trend logs to the CxA for review.

C. During the Acceptance Phase, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify the Owner's representative.

D. During the Acceptance Phase, the Contractor shall maintain all controller network and workstation hardware and software in a state that will allow remote access by CxA to trend logs as specified below.

3.10 BAS TREND REQUIREMENTS

A. The BAS Contractor shall configure and analyze all trends required under this section

B. Trends are historical archives on computer disks that document the operation of the systems and equipment. Trends can be time-series (interval) recordings of system I/O parameters or change-of-value (COV) based trends that record when a system value changes by more than a specified threshold.

C. CxA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CxA.

D. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same time intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.

1. Microsoft Access Database (.mdb)
2. Microsoft Excel Spreadsheet (.xls)
3. Comma Separated Value (.csv or .txt), preferably with quotes delimiting text fields and # delimiting date/time fields.

E. Sample times indicated as COV (±) mean that the changed parameter only needs to be recorded whenever the value changes by the amount listed. When output to the trend file, the latest recorded value shall be listed along with the time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the time interval common to other point trends for the system.

F. Contractor shall provide the CxA with required passwords, phone numbers, etc. to allow the CxA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.

G. Trending Requirements: All I/O points on primary equipment shall be trended throughout the Cx process on 10 min. intervals for analog values and change-of-value for binary values. Trends shall include but are not necessarily limited to the following points:

1. Outside air temperature
2. Outside air relative humidity
3. Outside air enthalpy
4. Cooling tons
5. All sensed hydronic temperatures
6. All sensed air temperatures and relative humidity measurements on primary equipment
7. All damper outputs on primary equipment
8. All valve outputs on primary equipment
9. All sensed fan volumes (flow) on primary equipment
10. All inputs and outputs to VSDs
11. Return (or exhaust) air temperature on each air handler
12. All safety indications
13. Status on all primary equipment
14. All air and water pressures on primary equipment or systems
15. Zone temperatures
16. Electricity consumption where monitored.
17. Domestic Water flow.
18. Basically all points on primary equipment and selected sampling of terminal points unless approved otherwise

H. Trending used to document ongoing FPTs may occur at a more frequent interval. Consult with the CxA to determine the required intervals for functional testing and modify intervals as required.

3.11 TREND GRAPHS

A. Trend graphs shall be used during Functional Performance Testing to facilitate and document testing. Contractor shall prepare controller and workstation software to display graphical format trends throughout the Acceptance Phase. Trend graphs shall demonstrate compliance with contract documents. Trended values and intervals shall be the same as those specified for the Functional Performance Tests.

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types or different line colors.

C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.c., Btu/lb, percent wide open, etc.

D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.

F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended simultaneously and on a common trend period.

G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.12 WARRANTY PHASE - OPPOSITE SEASON TRENDING AND TESTING

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Phase. BAS Contractor shall forward archived trend logs to the CxA for review upon CxA request. CxA will review these and notify BAS Contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, CxA shall schedule and conduct Opposite Season Functional Performance Testing. The BAS Contractor shall support this testing and remedy any deficiencies identified.

3.13 SOFTWARE OPTIMIZATION ASSISTANCE

A. The Contractor shall provide the services of a BAS technician as specified above at the project site to be at the disposal of the CxA. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the CxA during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, CxA, and Owner. The Owner's representative shall notify Contractor 2 days in advance of each day of requested assistance.

B. The BAS technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS technician provided cannot perform every software task requested by the CxA in a timely fashion, Contractor shall provide additional qualified personnel at the project site as requested by the CxA to meet the total specified requirement on-site.

3.14 BAS OPERATOR TRAINING

A. Provide up to 6 complete sets of User Manuals (hard copy and one electronic copy) to be used for training.

B. BAS Contractor shall submit a Training Plan per the requirements of Div 01 to the GC who will forward it to the A/E and CxA for review.

C. On Site Training: Provide services of BAS Contractor's qualified technical personnel for five 8-hour days to instruct Owners personnel in operation and maintenance of the BAS. Instruction shall be in classroom setting at the project site

for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner's representative shall notify Contractor 1-week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the A/E, CxA and Owner's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall be as follows:

1. Basic Operator Workstation Training – 8 hours for all potential users of the OWS in 4-hour non-contiguous segments:
    a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
    b. Brief overview of the various parts of the BAS O&M manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and BAS programming documentation.
    c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
    d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
    e. Overview of systems installed.
    f. Present all site-specific naming conventions and points lists, open protocol information, configuration databases, back up sequences, upload/download procedures, etc.
    g. Overview of scheduling procedures.
    h. Overview of alarm features, including how to acknowledge, respond to, and archive alarms, and how to access further information from them.
    i. Overview of trend features, including how to set up and view trends.
    j. Overview of workstation reporting features and introductory level report generation and scheduling.
2. BAS Technician Training: One24-hour training sessions that can be in 4-hour non-contiguous segments for individuals who will troubleshoot the system hardware, I/O devices, and the systems in general.
    a. General review of sequence of operation and control logic for the project site, including standalone and fail safe modes of operation;
    b. Uploading/downloading and backing up controller configuration and application programs;
    c. Review of installed components including all communication devices, controllers, I/O, etc., and how to install/replace, maintain, commission, and diagnose them;
    d. Introduction to controller programming and overview of the programming application interface;
    e. Defining trends, generating graphs in real time; archiving trends, accessing historical archive and generating reports from them;
    f. Introductory network administration;
    g. Introduction to creating and editing graphics;
    h. Review of setpoint optimization and fine-tuning concepts;
    i. OI use and maintenance;
    j. Web page creation as applicable.
3. System Administrator Training: One 8-hour session that may be done in two 4-hour segments on non-contiguous days. Target audience is the person who will be maintaining the system from an IT perspective as well as Owners IT personnel. Agenda shall be as follows:
    a. Overview of system architecture including all routers, bridges, repeaters, gateways, communications protocols, servers, controllers, etc.;
    b. Overview of and recommendations for backing up and restoring the system configuration database;
    c. Server maintenance;
    d. Security Management: Assigning passwords and rights for various users on the server, workstations and GUI software.

4. Final Systems Operation Training
    a. The BAS Contractor shall conduct Final Systems Operation Training.
    b. Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CxA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CxA or the Owner.
    c. The Record BAS Shop Drawings shall be provided as a handout for the training.
    d. Scheduling, attendees, and training methods shall be as specified.

END OF SECTION

SECTION 23 09 00

BUILDING AUTOMATION AND AUTOMATIC
TEMPERATURE CONTROL SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. This Section is coordinated with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 23 05 02 – Basic Mechanical Requirements shall apply.

1.2 DESCRIPTION

A. The work described under this division is for all labor, materials, and equipment required for the construction of the Building Management System (BMS or BAS/Automatic Temperature Control/ (ATC) system.

B. The system shall be complete in all respects, tested and ready for operation.

C. All materials, equipment and apparatus shall be new and of first-class quality.

D. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories and comply with NEMA standards, The Building Code of the City of New York, and the National Electric Code.

E. "Operator" is defined as the Owner's representative designated to operate the BMS/ATC system after Owner acceptance.

F. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, a building automatic system as shown on the drawings and hereinafter specified.

G. The Building Automation System shall be provided by the same manufacturer as the automation temperature controls.

H. The Automation System subcontractor shall furnish and install all equipment, accessories, wiring and instrument piping required for a complete and functioning system.

I. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.

J. The automation system shall be of a fully modular architecture permitting expansion by adding computer memory, application software, operator peripherals and field hardware.

K. If expansion of the automation system necessitates greater computer processing power, it shall be possible to transfer all existing software and data base, both vendor supplied and user-defined, to a new more powerful computer. This shall be accomplished by using removable, compatible disk cartridges.

L. Systems which require the existing user-defined data base to be reentered through the operator's terminal shall not be acceptable.

M. Although fire alarm and security points will not be installed or monitored, initially the system shall be installed completely ready to receive or accept these points at a later date without additional central hardware or software.

N. The system as specified shall monitor, control, and calculate all of the points and functions as listed in the Building Automation Schedule.

O. The system as installed shall have sufficient computer memory and application software for 100% point expansion above those points required and as listed in the Building Automation Schedule.

P. The Work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete the place into satisfactory operation a complete system of automatic temperature controls as shown on the Drawings and hereinafter specified.

Q. The control system shall be of the electronic fully modulating type unless otherwise indicated, or as hereinafter specified. Control equipment shall be as manufactured by Andover, Siemens, Johnson Controls, Inc., Automated Logic Corporation, or Honeywell, Inc. All controls shall be the product of one manufacturer. The temperature control manufacturer shall be responsible for the quality and satisfactory operation of material provided even if not actually manufactured by him.

R. The control system shall include all necessary temperature sensors, damper motors, relays, sensors valves, etc., and all necessary equipment for a complete control system, regardless of whether or not specifically mentioned.

S. The control system shall include all control and interlock wiring. The control wiring shall include all wiring, including power wiring for sensors, controls, control devices, relays, freezestats, firestats and all other necessary equipment to provide a complete control system, regardless of whether or not specifically mentioned, unless otherwise shown on the electrical drawings, including electric relays and contactors required for control interlocking. Interlock wiring shall include interlocks between fan starters between pump starters between starters and remote condensing units, between pumps, chillers and cooling towers and wherever else called for in these specifications. Unless otherwise noted; all control circuits shall be 120 volts or less.

T. Provide nameplates on all devices, whether or not mounted on the face of local control panels. In occupied areas, nameplates shall be concealed beneath covers of room type instruments, to describe functions.

1.3 GENERAL INSTRUCTIONS

A. The BMS/ATC systems as specified herein shall be provided in their entirety by the BMS/ATC Contractor. The BMS/ATC Contractor shall base his Bid on the systems as specified.

B. The general provision of the contract (Division 1 and sections 23 05 01, 23 05 02, and 23 05 03) apply to work specified in this section.

C. Requirements for panels, CPU’s and other major devices.

1. Include manufacturer’s literature for each type of panel, controller or device that may be shown on the block Diagram.
2. Block Diagram shall show, schematically, the entire building system with all major components identified.
3. Include a points list for all input and output devices which shall be provided by the proposed systems.
4. Include information about proposed communications buss and data transmission.

5. Provide a written explanation of any characteristics, items of equipment or control intent, which differs from the requirements of this Division. Explain what, if any, alternative characteristics, items of equipment or control intent will be provided.
6. Alternate systems, characteristics, items of equipment or control intent, which do not comply with these specifications may be rejected if not acceptable to the Engineer. Any rejected alternate system, characteristics, items of equipment or control intent shall be replaced by the specified system, characteristics, items of equipment or control intent at no extra cost to the project.

1.4 QUALITY ASSURANCE

A. Only firms regularly engaged in manufacture and installation of this equipment with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years shall be acceptable.

B. The entire building automation system shall be installed by skilled electricians and mechanics, all of whom are properly trained and qualified for this work. All wiring shall be installed in accordance with the Project Electrical Specifications.

C. Supervision and checkout of the system shall be by factory-trained engineers and technicians directly employed by the automation Contractor.

D. Provide system produced and installed by the manufacturers, which are listed in Section "Approved Manufacturer's List".

E. Provide equipment which performance, under specified conditions, is certified by the manufacturer.

1.5 SCOPE

A. The proposal shall be based on an electronic or electronic/pneumatic system. Valve and damper actuators may be electronic actuated and DDC controlled. Provide electronic sensors and transmitters with full DDC capabilities.

B. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BMS/ATC systems, as specified hereafter, shall be provided under this division by the BMS/ATC Installer.

C. The BMS Contractor shall guarantee that the installed system is capable of maintaining the following comfort goals in conditioned areas served by the BMS.

1. Space Design Temperature +/- 1ºF.
2. Relative Humidity 50% +/- 5%.
3. The BMS Contractor is not responsible for improper installation by other Divisions, however the BMS Contractor is responsible for informing the Construction Manager and Engineer of any requirements of this specification or any installation problem which prevents these goals from being maintained.

D. The contractor shall be responsible for all power and control wiring for BMS equipment including BMS panels, actuators, dampers, controllers, control power transformers, relays, etc. work shall be sub-contracted to a licensed electrical contractor by the BMS contractor if the BMS contractor is not suitably licensed. All work shall be completed in accordance with the electrical specification sections of this specification.

E. In the event of a power outage, upon restoration of normal power, the building systems shall be restarted in priority of criticality with a slight timing delay between starts to minimize the power inrush.

F. All points of data collected in the BMS shall be available for export to the campus dashboard system. Lucid Building OS or Lucid Dashboard will be provided by Owner using data points made available by BMS contractor.

1.6 ITEMS REQUIRED TO BE COORDINATED WITH OTHER DIVISIONS

A. Be responsible for coordinating the following:

1. Power requirements (voltage, amps, location) for all BMS equipment requiring power. See Section 23 05 01.

B. Installation and connection of all power wiring. Power wiring shall be defined as follows:

1. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
2. 120 VAC Emergency and 120V Normal power feeds to all BAS temperature control panels and equipment.
3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the BAS/ATC Contractor.

C. Note that 120V to 24V surge protected transformers for low voltage wiring by this Division shall be furnished, set in place and wired (from designated circuit in electrical panel) by this Division, and all low voltage control wiring shall be installed under this Division.

1.7 WORK BY OTHERS

A. The following work shall be provided under separate divisions of the specifications:

1. Installation of all line size and non-line size automatic valves and separable wells. However, these devices shall be furnished under this division.
2. Provision of all necessary piping connections, taps and direct-contact wells required for flow, pressure or temperature devices specified under other divisions.
3. Provision of manual balancing dampers as specified under other divisions of Divisions 21 through 23.
4. Installation of all automatic control dampers shall be by HVAC Contractor. All control dampers shall be furnished under this division.

1.8 AGENCY LISTINGS

A. UL 916 PAZX Energy Management Systems.

B. FCC-Part 15 Subparagraph J. Class A. Emissions requirements.

C. UL-864/UUKL Smoke Removal.

1.9 RELATED SECTIONS

A. 23 05 01 - Mechanical and Electrical Coordination.

B. 23 05 02 - Basic Mechanical Requirements.

C. 23 05 03 - Basic Mechanical Materials and Methods.

1.10 BMS/ATC CONTRACTOR

A. The BMS/ATC Contractor shall have a local office within a 50 mile radius of the job site, staffed with factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency maintenance service on all system components. The BMS/ATC Contractor shall have a ten year experience record in the design and

installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history prior to Contract Award should the Owner request it.

B. The BMS/ATC Contractor shall be prepared to make a personal presentation of his systems to the Owner or his designated representatives prior to award of Contract should the Owner request it.

C. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BMS/ATC systems, shall be provided under this division by the BMS/ATC Installer.

D. Control components shall be mounted and wired by the BAS/ATC Contractor except as noted. Controllers may be mounted on terminal units at the factory.

1.11 SUBMITTALS AFTER CONTRACT AWARD

A. The following data/information shall be submitted for approval:

1. Complete sequence of operation.
2. Control system CAD generated drawings including all pertinent data to provide a functional operating system.
3. Valve, and damper schedules showing size, configuration, capacity and location of all equipment.
4. Data sheets for all hardware and software control components.
5. A description of the installation materials including conduit, wire, flex, etc.
6. Building Management System panel locations.
7. Schematic and flow diagrams indicating sensor and device locations.
8. A list of all points with summary counts, including alarms and trend.
9. Operating schedules including Vassar holidays and breaks.

B. The Controls Contractor shall provide submittal drawings for the entire control system for review and approval before work shall begin. Included in the submittal drawings shall be a diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation. This shall be submitted in both hardcopy and editable electronic format.

C. Points list includes, for each physical or logical point, the name, description, display units, alarm limits, and definitions, along with the object description, object ID, and associated device ID. The list shall also indicate whether Trend Log or Schedule objects have been established for the point.

D. The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of this specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance.

E. Wiring diagrams shall include internal wiring of all electrical control devices.

F. Submit completed computer graphics for all the equipment and building floor plans and equipment prior to scheduled completion of the project for approval.

PART 2 – PRODUCTS

2.1 GENERAL

A. The Building Management System (BMS) shall provide an easy to use interface for monitoring and managing the building. The Building Management System shall provide the necessary Hardware, Software, and Network Communication abilities to provide Scheduling, Monitoring, Trending, Historical Storage, and Alarm Functions for the HVAC equipment and systems as described in this specification. Control capabilities shall include: Time of Day scheduling, Direct Digital Control, Custom Control, Boolean Logic, Optimum Start/Stop, Duty Cycling, Electrical Demand Control, Temperature Control, After Hours Override, Reports and Logs, Trend Prints, Remote Communications, Alarm Logging, Run Time and Maintenance, and Expanded Informational Messages.

B. The Building Management system shall be designed to allow full Operator operation with a minimum of training. It shall have an on-screen “Help” Operator tutorial.

C. Specified application programs shall be engineered, programmed and pre-tested prior to site installation. This shall be verified by standard format programming worksheets or flow diagrams included with the submittals.

2.2 BUILDING MANAGEMENT SYSTEM

A. Each panel memory shall be protected for a minimum of 48 hours in the event of power failure. Internal clock shall continue to run during a power failure so that the system makes the appropriate adjustment to all connected points when power is restored.

B. When specified or indicated on the point list or where required by the sequence of operation, outputs shall have three position manual override switch (On/Off/Auto), a status light, and shall be selectable for either normally open or closed operation.

2.3 MANUFACTURERS

A. Acceptable Manufacturers Are:

1. Andover Control – Day Automation
2. Andover Controls – EMF
3. Andover Controls – Richmar
4. Andover Controls – ACL

2.4 OPERATOR INTERFACE

A. Local Interface. Furnish one PC based workstation(s). Each of these graphics based workstation(s) shall be able to access all information in the system. These workstation(s) shall reside on the same high speed LAN as the building controllers. Each workstation shall be able to be custom configured based on the needs of the operator.

B. Hardware. Each operator workstation and custom programming workstation shall consist of the following:

1. Personal Computer. The CPU shall operate at a minimum of 2 GHz. A minimum of 16 GIGA BYTE of RAM, 48X DVD/CD Burner, Windows 7 Professional Operating System, a 1 TERA BYTE solid state hard disk with a maximum access time of 12 milliseconds shall be provided. A three button mouse will also be provided. Furnish all required serial, parallel, and LAN communication ports for proper system operation. The PC shall have a minimum of a 19” LCD monitor. PC shall be IBM compatible.
2. Megabit Ethernet card.
3. Printers: Each work station shall have one (1) printer, with tractor feed, and associated cables. Each printer shall be capable of a minimum 160 characters per second operation and be compatible with standard parallel or serial communications.

C. Workstation Software

1. Multiple Users: The system shall accommodate simultaneous multiple user operation. Access to the system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the system and have access to all valid data.
2. Operating System: Furnish a concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under Microsoft Windows.
3. System Graphics: The Operator Workstation software shall be graphically oriented. The system shall allow display of up to multiple graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the point.
    a. Standard Graphics. Provide graphics for each major piece of equipment in the building. This includes but not limited to, each Chiller, Air Handler, VAV Terminal, Fan Coil, Boiler, and Cooling Tower. These standard graphics shall show all points as specified in the points list.
    b. Custom Graphics. The system shall have custom graphics provided for all air handling systems and hydronic systems. Graphics shall also include actual floor plans showing equipment, and sensors. Custom graphic files shall be created with the use of a PC Paint package furnished with the system. The PC Paint package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The PC Paint package shall also provide the capability of capturing or converting graphics from other programs such as Designer, or AutoCad.
    c. Graphics Library. Furnish a complete library of common HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library shall also include symbols for other equipment including fans, pumps, valves, piping, and ductwork. The library shall be furnished in a file format compatible with the PC Paint Program.
    d. Photo Quality Input. The system shall be able to accommodate high resolution digitized photographs. The owner shall be able to edit the photo quality graphics using the furnished PC Paint Program.
4. Workstation Applications. The workstation shall serve as the primary area of the system for operator interface and off-line storage of system information. The workstation shall also serve as the bridge to other building systems. Provide the following applications at the workstation.
    a. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
    b. System Configuration. The workstation software shall provide a simple to use graphical method of configuring the system. As elements are located on the site they shall be displayed on a graphical representation of the system. This shall be flexible to allow for future system changes or additions.
    c. On Line Help. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
    d. Security. Each operator shall be required to log on to the system with a user name and a password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object (i.e. Operator One can view and change all airside data but only view chiller plant data, operator two can only acknowledge alarms and not view or change system data etc.) Each operator shall automatically be logged off of the system if no keyboard or

mouse activity is detected. This auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format in the building management panels.

e. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, LAN connections, building management panels and controllers. The failure of any device shall be annunciated to the operator.

f. Trend Logs. Each object in the system shall automatically be trend logged. This trend shall be stored for a minimum of 24 hours. The operator shall be able to view this trend on demand.

g. Event Log. The operator shall be able to view all systems alarms and change of states. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

h. Point Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu on graphics or through custom programs.

i. Clock Synchronization. The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically sequence all system clocks, daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.

5. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, states and reactions for each object in the system.

a. Binary Alarms. Each binary object shall be set to alarm based on the operator specified state. Provide the capability to automatically and manually disable alarming.

b. Analog Alarms. Each analog object shall have both high and low alarm limits a well as high and low “early warning” limits. Provide separate sets of limits for both occupied and unoccupied (on/off) conditions. Alarming must be able to be automatically or manually disabled.

c. Alarm Reactions. The operator shall be able to determine what action if any are to be taken, by object, during an alarm. Actions shall include logging, printing, starting programs, displaying messages, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. The system shall provide multiple levels of alarm priority.

6. Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide graphically based editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the building management panels.

a. Application Specific Controller. Provide a full page editor for each application specific controller. This shall allow the operator to view and change the configuration, name, control parameters and set points for each device.

b. Scheduling.

1) A complete graphically based editor for the scheduling application shall be provided at each workstation. Provide an easy to use method of selecting the desired schedule and month.

2) This shall consist of graphically represented daily schedules and holidays.

3) Provide the capability for seasonal schedules that will be automatically executed during user defined periods. This shall enable the operator to have a group of equipment in discrete “Summer” and “Winter” schedules. Each seasonal schedule shall only be active during the operator specified time periods. The schedule shall be available for viewing and editing even when not active. The operator viewing a schedule shall be able to see graphically whether the schedule is active or inactive for up to a year in advance.

4) An operator with proper password level shall be able to modify the schedule. Schedules shall be able to be easily copied between objects and/or dates.

7. Custom Programming Language. Provide the capability to perform custom applications. The custom programming editor shall be accessible from all workstations. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. Systems that require the operator interface be shut down to edit and compile programs shall include and additional Custom

Programming Workstation. This workstation shall be identical to the operators workstation in section 2.04.B.2.A.

The Program editor shall allow for creation, editing, troubleshooting, and simulation of custom programs. The editor shall check for proper programming context, use, spelling, and format. The custom programming editor shall also compile the program and be able to upload and download to the building management panel. All custom routines shall be executed at the building management panel.

8. Alarm Annunciation.
   a. Upon the incidence of an alarm, an alarm window shall be displayed showing the point in alarm, the time and date of the alarm and a user-selected predefined alarm message (and optionally printed to a user defined printer, printers and/or VT-100 or dumb terminal devices). Alarms shall be displayed regardless of the application in use including any non-ddc system DOS or Windows applications. The program shall display the current unacknowledged and acknowledged alarms. The user shall be able to selectively enable or disable a reminder in the event there are unacknowledged alarms. This reminder shall be both visual and audible. The user shall be able to record their own reminder messages and select the frequency at which they will play.
   b. Acknowledgement of alarms shall be from the alarm “pop-up” and/or from a separate alarm summary. Acknowledgment shall be by a specific event, date range, class, or specific alarm definition and condition. Upon acknowledging the alarm, the name of the operator acknowledging the alarm and the time and date will be associated with the acknowledgement, this data will be stored to the alarm history file and printed to the chosen printers or terminal devices.
   c. The system shall allow automatic or manual display of associated dynamic graphic screens and trend charts shall be provided for each alarm.
   d. Upon exiting the alarm handling mode the user shall be placed back to the application in use at the time of alarm/exception occurrence.
   e. A current alarm screen shall be provided which will dynamically display only alarms that are currently in alarm. As alarms are return-to-normal from their respective alarm states the current alarm screen shall be dynamically updated to reflect the change.
9. Trend Management
   a. The program shall automatically perform time based periodic collection of real time point data and subsequently store it to the systems hard disk. There shall be local and remote modes of operation. Local collection shall allow the program to directly query the controllers for individual point samples. Remote collection shall mean the controllers collect and store trend data on individual points and then release the entire trend table(s) upon a request from the computer work station.
   b. Storage and manipulation of sample points shall only be limited by disk space. Sampling rates shall be user selectable from instantaneous (once a second or less) to once a week. Collection of data shall be user selectable to start and stop on specific times and dates.
   c. Charting of the trend data shall be an integral part of the trend management program. Third party graphing packages such as Excel shall not be required to implement this program. Multiple points shall be chartable. Multiple X/Y charts may be run simultaneously displaying either real time data (instantaneous) or historical. Y scaling shall be either automatic or user selectable for any chart displayed, each chart may have different scaling. X scales shall be user selectable allowing for display of data over the wide range of times and dates. Multiple years of data shall be allowed. The chart display shall be capable of displaying a window of time as short as 15 seconds. Average, high and low values shall be displayed for selected point.
10. Reporting
   a. The report section shall be the gateway to the database for all data collected and shall provide an easy means of reporting and information management.
   b. The report generator shall be an integral part of the system. Offline third party packages (such as Excel) for report manipulation shall not be required to implement this program.
   c. Reports on historical trend data shall allow for daily, weekly, monthly and yearly reporting. These reports shall be completely flexible on the data items to be reported on. The user shall be able to

select from a list of predefined reports or selected data items on-the-fly. The selection of data item shall not be restricted by panel source. Reports shall have multiple columns and be infinite in length. Reports must be capable of reporting on data that has been collected at varying time intervals. Report generator shall allow an operator to easily and quickly define the contents of a report as well as define a print time and date if so desired. Information contained in the reports shall be derived from alarm history, system database, trend data and timed overrides.

d. The operator shall be able to compile reports by user, department, time and data period, point or points.

11. Multi-tasking

a. The system shall be capable of true multi-tasking capabilities. The user shall be able to use other non-related programs in the system while still running all ddc system application with no interruptions. This shall include the use of real time data in other applications. This feature shall allow spread sheet programs to gather data from the system dynamically while running a dynamically updated graphic screen. The system shall have the ability to allow the passing of data freely to MS Windows application, which incorporate the use of Dynamic Data Exchange.

D. Operator Interfaces: Provide at least one alphanumeric human-machine interface (HMI) per mechanical room. The HMI shall allow the user to:

1. Read the value of a measured variable.
2. Start or stop equipment.
3. Monitor the status of controlled equipment.
4. Read the setpoint, reset and modify tuning parameters of control loops.
5. Read all active alarms.

2.5 SYSTEM PERFORMANCE

A. The system shall consist of Operator Workstation, Building Management Panels, and Application Specific Controllers. All elements of the system shall be designed for standalone operation. Control shall always occur at the lowest level of the system. Communication between the building management panels and workstations shall be over a high speed communications buss. All nodes on this LAN shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the building management panels to update point information and alarm information.

2.6 SYSTEM APPLICATION CONTROLLER SOFTWARE

A. System Security: User access shall be secured using individual security passwords and user names.

B. Passwords shall restrict the user to only the object, applications and system functions as assigned by the system manager.

2.7 SYSTEM SOFTWARE

A. Furnish the following applications for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.

1. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each scheduler shall consist of the following:

a. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each scheduler may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each number.

b. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to one year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
c. Holiday Schedules: Provide the capability for the operator to define up to 30 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

2. Optimal Start/Stop: The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. Provide an early start limit in minutes to prevent the system from starting too early.
3. System Coordination: Provide a standard application for the proper coordination of equipment.
4. Alarm Reporting.
5. Trending.
6. Diagnostics.
7. Power Fail Recovery.
8. Reports and Logs.

2.8 NETWORK CONTROLLERS

A. General. Provide an adequate number of Building Management Panels to provide the performance specified above. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent stand-alone, microprocessor based Network Controllers to manage the global strategies describes in Application software section.
2. The Master Controller shall have substantial memory to support its operating system, database, and programming requirements.
3. The multi-tasking operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
4. Data shall automatically be shared between Master Controllers when they are networked together.
5. The database and custom programming routines of remote Network Controllers shall be editable from a single operator station.
6. The Master Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
   a. Assume a predetermined failure mode.
   b. Emit an alarm.
   c. Display card failure identification.

B. Communications. Each Master Controller and Operator Workstation shall communicate using 10/100/1000 Ethernet (IEEE802.3). This LAN shall be self configuring and shall automatically reconfigure as nodes are added or removed.

1. Hard Wired Connections. Provide a twisted pair copper (CAT.5E or higher) cable between all nodes on the system LAN. Provide all necessary network switches to complete the network.

C. All controllers shall allow communication over open protocol such as LonTalk or BACNET. Open protocol; shall be appropriate to the signal being transmitted and shall selected to best communicate with the domains open protocol for systems that have been previously installed at the facility.

D. Serviceability. The Network Controller should be designed in a modular fashion so that the enclosure may be roughed in prior to the installation of the electronics. Provide diagnostic LEDs for power, communications, and alarms. The controller shall have provisions for expansion and future controller architecture. All wiring connections

shall be made to field serviceable terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Network Controller shall maintain all BIOS and programming information in EEPROM. The system BIOS shall be easily upgradable for the PC workstation without the need for going out to the panel. System manufacturer shall provide current version software and firmware at the end of the warranty period.

F. Controller software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the failure mode requirements defined on the drawings. In this state it shall issue an alarm.

G. Volatile memory is required to be backed up in the event of power loss. Software stored in non-volatile memory will not have to be downloaded from the central server after an interruption of power occurs.

H. Controllers used for time-scheduled operations must be equipped with a battery backed internal real-time clock function to provide a time base for implementing time-dependent programs. Provision shall be made for the routine updating of the controllers' clocks via a time master.

I. Resumption of power after an outage shall cause the controllers to automatically restart and establish communications as needed by their applications. Controller shutdown based on a self-diagnosed failure in the power supply, hardware, or software must set each piece of controlled equipment to a predetermined failure mode.

J. Controllers shall be powered from the most reliable source that powers any of the systems it serves. In the situation where a controller will be required to continuously collect data to be transmitted to a workstation, or where it monitors critical recovery information such as the presence of emergency power, it may be necessary to provide a UPS for the controller as well as any critical sensors. Where panels are provided with a different power source as the equipment (such as when the panel is on a UPS), the panel shall be provided with a means of monitoring the power source to the controlled equipment. This can be a dedicated power monitor or a value coming from transfer switch contacts.

2.9 APPLICATION SPECIFIC CONTROLLERS

A. Application Specific Controllers shall be stand-alone, microprocessor based Direct Digital Controllers with sufficient EEPROM memory to handle its operating system, database and programming requirements.

The controllers shall be clearly labeled as to controller type, where it is to be installed, and software address (if applicable). The controller shall be fully tested upon installation to ensure that it is properly matched to the equipment it is controlling.

B. The controller shall communicate with other devices on the communication network and be fully integrated with the other system components.

C. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures, and shall be rated for operation at –40°F to 155°F.
2. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.

D. Terminal Unit Controllers

1. The VAV terminal units shall be individually controlled by a dedicated DDC VAV controller. The DDC VAV controller, damper motor, transducer and transformer (if required) shall be supplied by the BAS contractor.

a. To assure proper operation and control, the BAS contractor as part of this bid, shall recalibrate the transducers six (6) months after acceptance of the BMS system to correct any deviations as a result of transducer drift.
b. Submit a copy of the recalibration report to the Engineer, Mechanical Contractor, Test, Adjust and Balance Contractor and Owner.

2. The BMS shall perform the following VAV Terminal unit control strategies and provide the points as listed on the DDC/VAV point list and specified monitoring and diagnostics.
   a. Grouping: The BAS shall be able to group VAV boxes via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. A sample of this group report must be provided in the submittal package for approval by Engineer and Owner. BAS shall also compile on a group basis, the following:
      1) Minimum group temperature.
      2) Maximum group temperature.
      3) Average group temperature.
      4) Current airflow through boxes in group (total).
      5) Total ventilation airflow in group (total).
   b. Setpoint Control: The BMS shall edit the zone space temperature setpoint of each VAV box. The zone temperature setpoint shall be operator adjustable. Individual zone setpoint and control logic shall reside at the zone level, and not be dependent upon the BMS for control. In the event of communication loss, the box will continue to control to current setpoints.
   c. Manual/Automatic Setpoint Control: Where indicated in the contract documents, provide a combination zone temperature sensor/temperature sensor (S/T) with master control via the Operator's Work Station. In automatic mode, the S/T shall operate only as a room sensor. In Manual mode, the space occupant shall have the capability to raise or lower space setpoint within limits established by BMS.
   d. Override Button: Where indicated on the contract documents, the VAV box shall be capable of being placed in the "occupied" mode. Operation of the over-ride shall energize the associated air handler.
   e. Override Cancel Button: The VAV box shall be capable of being placed back into the "occupied" mode by the zone occupant for a preset time period (adj.).
      1) The following areas shall have manual temperature re-set capability and unoccupied over-ride button:
         a) All office areas.
         b) All other areas shall have temperature sensing capability only.
   f. Cooling Valve Control: The BMS shall control the cooling air valve to a fully open, fully close, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum and minimum airflow limits of the air valve through the BMS.
   g. Operating Mode: The BMS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating and cooling setpoints shall be enterable for each mode through the BMS. Other modes available for special applications shall include full open, full closed, maximum flow, heating flow, minimum flow, etc.
   h. Occupied status shall be further divided into Game Day/Office/or Player Occupied schedule as appropriate. Certain public or player occupied areas shall have a higher "minimum occupied" setting for Game Day or Player Occupied time periods.
   i. Control Offset: The BMS shall be capable of offsetting the cooling or heating setpoints of one or more groups of boxes by an operator adjustable amount. This capacity will allow for automatic zone setpoint changes based on system requirements, such as demand limiting.
   j. Automatic Recalibration: The system shall automatically recalibrate its air flow sensing and air valve position measurement system at system startup and on a schedule basis.
   k. Portable interface terminal: The VAV box shall have a communications port on the space sensor for use with a hand held portable operator's terminal. This portable terminal shall give the operator the capability to interrogate and edit DDC/VAV box parameters. Portable interface terminal shall also have the capability to interrogate and edit DDC/VAV box parameters from a central controller.

l. Terminal Unit Status Reports: For each terminal unit, the BMS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), setpoint and modes.
m. Terminal Unit Group Report: For each group of VAV terminal units, the BMS shall report the group mode, heating and cooling airflow, average zone temperature, minimum zone temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group, the present temperature control setpoints and the current zone temperature.

3. Terminal Box Diagnostics:
   a. If zone temperature sensor input fails above its high range, unit shall control at its maximum CFM setpoint. If sensor input fails below its low range, units shall control to its minimum CFM setpoint.
   b. In both cases, all heat outputs shall be disabled. A diagnostic message shall be displayed upon operator inquiry.
   c. If flow measuring system fails, unit shall automatically convert to a pressure dependent, damper position based algorithm. Diagnostic message shall be displayed upon operator inquiry.
   d. If zone temperature setpoint potentiometer on zone sensor fails, unit shall automatically control to programmed occupied setpoints. Diagnostic message shall be displayed upon operator inquiry.
   e. If communications are not lost, controller shall continue to operate in current mode of operation. All setpoints shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset-recalibrate.

E. Controller software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the failure mode requirements defined on the drawings. In this state it shall issue an alarm.

F. Volatile memory is required to be backed up in the event of power loss. Software stored in non-volatile memory will not have to be downloaded from the central server after an interruption of power occurs.

G. Controllers used for time-scheduled operations must be equipped with a battery backed internal real-time clock function to provide a time base for implementing time-dependent programs. Provision shall be made for the routine updating of the controllers' clocks via a time master.

H. Resumption of power after an outage shall cause the controllers to automatically restart and establish communications as needed by their applications. Controller shutdown based on a self-diagnosed failure in the power supply, hardware, or software must set each piece of controlled equipment to a predetermined failure mode.

I. Controllers shall be powered from the most reliable source that powers any of the systems it serves. In the situation where a controller will be required to continuously collect data to be transmitted to a workstation, or where it monitors critical recovery information such as the presence of emergency power, it may be necessary to provide a UPS for the controller as well as any critical sensors. Where panels are provided with a different power source as the equipment (such as when the panel is on a UPS), the panel shall be provided with a means of monitoring the power source to the controlled equipment. This can be a dedicated power monitor or a value coming from transfer switch contacts.

2.10 CUSTOM APPLICATION CONTROLLERS

A. The Custom Application Controllers shall provide stand-alone control and require no additional system components for complete operation. It shall have sufficient EEPROM memory to support its operation system, database, and programming requirements. Custom application controllers shall meet the requirements of 2.06 Master Control Panels except they shall reside on a communications network operating at a minimum of 38,400 KBPS.

B. All programming required for operation shall be memory resident and shall be retained in permanent memory.

C. The Custom Application Controller shall be configured such that the Portable Operators Terminal can be plugged directly into it or within sight for programming, editing, and other operator functions. Custom application controllers

shall also be programmable from the operator workstation.

D. Controller hardware shall be suitable for the anticipated ambient conditions.

E. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures and shall be rated for operation at –40°F to 155°F.

F. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.

G. Controller software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the failure mode requirements defined on the drawings. In this state it shall issue an alarm.

H. Volatile memory is required to be backed up in the event of power loss. Software stored in non-volatile memory will not have to be downloaded from the central server after an interruption of power occurs.

I. Controllers used for time-scheduled operations must be equipped with a battery backed internal real-time clock function to provide a time base for implementing time-dependent programs. Provision shall be made for the routine updating of the controllers' clocks via a time master.

J. Resumption of power after an outage shall cause the controllers to automatically restart and establish communications as needed by their applications. Controller shutdown based on a self-diagnosed failure in the power supply, hardware, or software must set each piece of controlled equipment to a predetermined failure mode.

K. Controllers shall be powered from the most reliable source that powers any of the systems it serves. In the situation where a controller will be required to continuously collect data to be transmitted to a workstation, or where it monitors critical recovery information such as the presence of emergency power, it may be necessary to provide a UPS for the controller as well as any critical sensors. Where panels are provided with a different power source as the equipment (such as when the panel is on a UPS), the panel shall be provided with a means of monitoring the power source to the controlled equipment. This can be a dedicated power monitor or a value coming from transfer switch contacts

2.11 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through Master Control Panel, Custom Application, or Application Specific Controllers. Any critical points requiring immediate reaction shall be tied directly in to the controller hosting the control software algorithm for the critical function.

B. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a sufficient wetting current to be compatible with commonly available control devices.

All status points shown on the point list shall be positive proof differential pressure or current sensing binary switches.

C. Analog inputs shall allow the monitoring of low voltage, current, or resistance signals and shall have a minimum resolution of 0.1% of the sensing range. Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.

D. Binary outputs shall provide a continuous low voltage signal for on/off control of remote devices. Where specified in the sequence of operations or indicated on the points list, binary outputs shall have 3-position (on/off/auto) override switches, status lights, and shall be selectable for either normally open or normally closed position.

E. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC, 0 to 20 VDC or a 4 to 20 milliampere signal as required to provide proper control of the output device. Systems that utilize a pulse width modulating output (PWM) shall include a position feedback AI for each output.

F. System architecture shall allow for point expansion in one of the following ways:

1. The addition of input/output cards to an existing System Application Controller.
2. An additional panel and/or controller may be used to expand point capacity.
3. Ten (10) percent expansion capacity for all point types in all DDC panels.

2.12 IDENTIFICATION

A. Engraved Labels

1. Material: Melamine plastic laminate.
2. Thickness: 1/16".
3. Color
   a. Surface: White.
   b. Core: Black (letter color).
4. Fastenings: Any of the following:
   a. Screws.
   b. Rivets.
   c. Permanent adhesive.
5. Lettering: Coordinate with shop drawings.

2.13 DUCT SMOKE DETECTORS

A. Duct smoke detectors shall be provided and wired in accordance with manufacturer's requirements.

2.14 BMS/ATC CONTROL WIRING

A. General: 18 AWG Twisted pair cable shield wire shall be provided if required by system manufacturer.

B. Provide for all input and all analog output wiring.

C. Tinned copper conductors.

D. Do not run input/output wires together in the same conduit or wire bundle with 120V power wiring.

E. Pneumatic or sensor tubing shall not be installed in conduit with any wiring conductors.

F. All control wiring shall be run in metal conduit as follows:

1. EMT in Mechanical/Electrical Rooms.
2. Rigid at exterior.
3. Plenum rated for concealed spaces/hung ceiling.

G. Unless specifically required otherwise by the BACS equipment manufacturer, all I/O wiring shall be twisted shielded cable. For communications, the BACS equipment manufacturer's installation guidelines and recommendations shall apply.

H. All control wiring in mechanical equipment rooms or other spaces in which it is readily accessible shall be installed in electrical metal tubing (EMT) with compression fittings.

I. All control wiring run in interstitial spaces shall either be run in EMT or a cable tray or raceway.

J. All control wiring installed outdoors or any area subject to moisture shall be installed per code.

K. All control wiring installed in vertical chases shall be installed in EMT.

L. All control wiring above non-accessible ceilings shall be installed in EMT.

M. All control wiring installed above accessible ceiling spaces which are not laboratories or AHU's shall be plenum type, not installed in conduit, but neatly run with generous use of rings or ties.

N. Wire shall be unspliced from the controller to the sensor or device.

O. Control wiring shall not be routed in the same raceway as power wiring.

P. For sensors with twisted shielded pair cable, the shield shall be grounded at the panel and taped back at the sensor.

Q. Control wiring shall be color coded and labeled at all points of termination.

R. Remove and properly dispose of all abandoned control wiring, conduit, tubing, boxes, enclosures, components, and other controls-related work.

2.15 DAMPERS

A. The Building Automation System supplier shall provide all automatic control dampers not specified to be supplied integral to the HVAC equipment.

B. Dampers shall be low leakage or high velocity low leakage air foil as specified in the sequence of operation or in the equipment specifications and schedules. All proportional dampers shall be opposed blade type, except mixing dampers shall be parallel type. Two position dampers may be opposed or parallel blade type.

C. Damper frames and blades shall be galvanized steel and a minimum of 16 gauge. Blade width shall not exceed 8 inches. Dampers and seals shall be suitable for temperature ranges of –50°F to 250ºF.

D. Blades: 14-gauge,or 16-gauge air foil shaped, double, galvanized steel or extruded aluminum.

E. Bearings: Nylon or oil impregnated.

F. Axles: Welded, hexagonal or pin lock, or with other approved method to prevent blade rotating on axle.

G. Hardware: Zinc plated steel or aluminum.

H. Low Leakage Dampers:

1. Where specifically called out as "LOW LEAKAGE", provide the following:
   a. Field replaceable edge and end seals with be installed along the top, bottom, and side of the frame and each blade. Seals and bearings shall be suitable for temperature ranges from –40ºF to 200ºF. Leakage shall not exceed 6 CFM/Sq. Ft. at 4" W.G. differential and 3 CFM/Sq. Ft. at 1" W.G. differential.
   b. High Velocity Low Leakage dampers shall be Ruskin, Model CD60 or equivalent.

I. Provide low leakage dampers in the following locations:

1. Outside air dampers.
2. Motorized backdraft dampers.
3. Motorized intake dampers.
4. Exhaust dampers.

J. Dampers shall be applicable for the rated pressure and velocity service. Damper structural rating shall exceed extreme anticipated conditions like fan deadhead.

K. Modulating dampers shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. Except where size dictates a single blade, dampers shall always be opposed blade. When a large section of damper is to be connected to a single jackshaft, size limitations shall be followed. This will prevent excessive damper area or, more importantly, length from being connected to a single jackshaft. Typically, the manufacturer's recommendation shall be sufficient for specifying a limit to the size of a damper bank that may have field fabricated jackshaft connections.

L. Whenever possible, dampers shall have external crankshafts to allow the connection of the damper actuator outside of the air stream. This will allow for easier access to the actuators for maintenance.

M. Outside air control dampers shall be low leakage dampers with damper seals.

N. Output to modulating control dampers shall be analog.

O. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Nailor

2.16 CONTROL VALVES

A. Provide control valves of the type, body material and pressure class as determined by manufacturer, based on operating requirements and maximum pressure and temperature in the piping system.

B. Equip control valves with actuators of proper close-off rating.

C. Modulating control valves shall have equal percentage or linear flow characteristics.

D. Valve bodies shall be 2-way normally open or closed or as required. Valve bodies 2" and smaller shall be bronze, screwed type and 2½" and larger shall be iron, flanged and rated at 240°F 125 psig except where otherwise noted.

E. Valves shall have stainless steel stems and allow for servicing including packing, stem, and disk replacement, or offer a 5 year warranty on parts and labor.

F. Size valves for 50% coil pressure drop (minimum 3', maximum 12' pressure drop).

G. Two-position, two-way control valves shall have quick opening characteristics.

H. Valves shall be applicable for the rated pressure and temperature service. Close off pressures must be determined in concert with the actuators and valves shall be provided to close off against extreme anticipated conditions. Valves shall be selected such that they are not, as a practice, "oversized."

I. Modulating valves shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. “Split ranging” of heating and cooling valves controlled by the BACS is not acceptable. A separate output from the BACS shall be provided for all control valves. General guidelines are indicated below. When the selection criteria indicated below are not met, flow characteristic analyses shall be submitted to demonstrate reasonable correlation between stroke and flow. Valves with a CV greater than 30 may be pneumatically actuated, but should only be used if a cost benefit analysis shows they are preferred. Actuator positioning requirements are as follows for each type, if used:

1. Electric Input: 4-20 mA or 0-10 VDC.

J. Pressure independent control valves can be utilized, but are not preferred. If used, they shall be two-way pressure independent control valves such that balancing of the valves and associated branch piping shall not be required. Requirements shall be as follows:

1. Absolute flow accuracy:

   a. +/- 5% due to system pressure fluctuations across the valve in the selected operating range.
   b. +/- 5% due to manufacturing tolerances.

2. The control signal shall be modulating.
3. The valves shall accurately control the flow from 0% to 100% of full rated flow.
4. A minimum of 2 PSI shall be required to operate the valve pressure independently.
5. The valves shall require no maintenance and shall not include replaceable cartridges.
6. The valves shall be available with optional pressure/temperature ports to allow for flow verification.

K. Coil Valves, Water

1. Modulating water valves will generally be ball valves with an equal percentage characteristic. Modulating water valves shall typically be sized for 50-100% of the typical controlled circuit pressure drop at 70% wide open CV. The minimum design CV shall be no less than 1.9. CV selected to give a 2 psig drop at maximum flow.
2. Water and glycol control valves shall be rated to remain closed (zero leakage) against 120% of the full shutoff head of the pumps, when the control signal is set to "fully closed".
3. Type: Two-way, V-port ball valve with characterizing disk, 1/4 turn.
4. Packing: EPDM O-rings, lubricated.
5. Ball & Stem: Stainless steel.
6. Seat: Fiberglass reinforced Teflon.
7. Actuator: Electric, one motor only; valves 4 inches and larger shall have single operator.
8. Flow Characteristic: Equal percentage.
9. Fail positions shall generally be as follows, contact Engineer for special circumstances requiring deviation from these requirements:

   a. Terminal hot water radiation: fail last.
   b. Heat pump motorized isolation valve: fail last.

10. Acceptable Manufacturers:

    a. Belimo
    b. Valve Solutions

2.17 VALVE ACTUATORS: (ELECTRIC)

A. Valve actuators shall be electronic low voltage (24VAC), and properly selected for the valve body and service. Belimo or equivalent.

B. Actuators shall be fully proportioning (if modulating) and be spring return for normally open or normally closed operation as called out in the sequence of operations.

C. Provide a handwheel or manual positioner mounted adjacent to valve to allow manual positioning of valve in the absence of power.

D. Tri-state floating control non-spring return actuators are acceptable for terminal reheat applications for sizes less than one inch.

E. Actuators that rely on heating a medium are not acceptable.

2.18 BUTTERFLY VALVES

A. Butterfly valves used for automatic control shall be lug type rated for 125 psi non-shock water service to 180°F. Valve body shall be ductile iron with B-Nitrite (BUNA N) or EPDM molded seat and seals.

B. Disc material shall be cast bronze of aluminum-bronze with ASTM A-492 Type 416SS stainless steel stem and fittings.

C. Valves shall be tight close off suitable for end of the line service.

D. Butterfly valves used for two position control shall be line size. Valves used for modulating control shall be sized for a minimum 5 psig differential pressure at full flow. Butterfly valves shall not be used for modulating control without specific approval from the engineer.

2.19 TEMPERATURE SENSORS

A. Temperature sensors shall be Resistance Temperature Detector (RTD) or Thermistor as dictated by the requirements of this specification.

B. Duct sensors shall be rigid or averaging as specified in the sequence of operations. Averaging sensors shall be a minimum of 5 feet in length.

C. Immersion sensors shall be provided with a separable stainless steel or brass well to match pipe material.

D. Space sensors shall be equipped with setpoint adjustment and/or override switch as specified on the plans or in the sequence of operations. Space sensor shall have a portable service tool jack.

E. Accuracies shall be +/-1°F for standard applications. Where high accuracy is required, accuracies shall be +/- .2°F.

F. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacturer's recommendation and looped and fastened at a minimum of every 36 inches.

G. Sunshields shall be provided for outside air sensors.

1. Provide one OA sensor per mechanical room and whenever the communication rated is greater than 100 kbps.

H. Sensor Resolution: When matched with A/D converter of the controller, sensor range shall provide a resolution of no less than 0.4 °F (unless noted otherwise).

I. Room Temperature Sensor: These shall be an element contained within a ventilated cover, suitable for wall mounting. Provide an insulated base.

1. Sensing element: RTD or thermistor, +/- 0.8°F accuracy at calibration point.
2. Setpoint Adjustment: Provide where indicated. Public spaces shall not have setpoint adjustment. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BACS.
3. Occupancy Override: Provide a button on the room sensor enclosure where indicated, generally in office spaces that do not have occupancy sensors. Public spaces shall not have occupancy override. This shall be a momentary contact closure.
4. Display: Alphanumeric.
5. Sensors shall be provided with communication jack and appropriate cabling for connection to the BACS.

J. Single Point Duct Temperature Sensor: These shall consist of a sensing element, junction box for wiring connections, and a gasket to prevent air leakage or vibration noise. The sensor probe shall be stainless steel.

1. Sensing element: RTD or thermistor, +/- 0.5°F accuracy at calibration point.

K. Averaging Duct Temperature Sensor: These shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one foot of sensing element for each, two square feet of coil/duct face area.

1. Sensing element: RTD or thermistor, +/- 0.5°F accuracy at calibration point.

L. Liquid Immersion Temperature Sensor: These shall include brass or stainless steel thermowell, sensor and connection head for wiring connections.

1. Sensing element: RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
2. Temperature Range: As required for resolution of 0.3°F.

M. Outside Air Temperature Sensor: These shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. On major/critical systems, one outside air temperature sensor shall be provided for each system; and one sensor shall be provided per mechanical room, or building-level controller. Generally, these shall be located on a north wall of the building and installed with stand-offs. On 100% outside air systems, locate the sensor in the outside air plenum.

1. Sensing element: RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

2.20 HUMIDITY SENSORS

A. Humidity sensors shall be capacitance or bulk polymer resistance type.

B. Duct and room sensors shall have a sensing range of 20 to 80% with accuracy of +/-3% R.H. Duct sensors shall be provided with a sampling chamber.

C. Outdoor air humidity sensors shall have a sensing range of 20 to 95% RH. They shall be suitable for ambient conditions of –40°F to 170°F.

D. Units shall be suitable for duct, wall (room), or outdoor mounting. Sensors shall be two-wire transmitters utilizing bulk polymer resistance change or thin film capacitance change. Units shall produce linear continuous output of 4-20 mA for % RH. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dew point calculation, or humidifier control); or +/- 3% (when used for monitoring) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
3. Operating Range: As required by the application.
4. Long Term Stability: Less than 1% drift per year.
5. Acceptable Manufacturers:

    a. Vaisala
    b. Mamac
    c. Veris Industries

2.21 DIFFERENTIAL PRESSURE & CURRENT SWITCHES

A. Differential Pressure Switches shall be furnished as indicated for status purposes in air and water applications. Provide single pole double throw switch with fully adjustable differential pressure settings.

B. Sensing range shall be suitable for the application with accuracy of +/-2% of range and repeatability of +/-.5 % of range. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.

C. Current switches shall be provided for status indications on variable air flow fans and variable pump speed applications. These switches shall be capable of installation and replacement without removing power wiring.

2.22 STATIC PRESSURE SENSORS

A. Static pressure sensors shall be differential pressure type. The sensor range shall be closely matched to the system static pressure, - .5 to .5 inches, -1 to 1 inches, 0 to 2.5 inches.

B. Sensor accuracy shall be plus or minus 5% of the sensing range, and repeatability of 2% of sensor range.

2.23 FREEZE PROTECTION DUCTSTATS

A. An electric freeze protection ductstat with 20 feet low temperature sensing capillary, and with manual reset, shall be located across the entering face of each cooling coil or bank of coils in the air conditioning unit or in the discharge of each heating coil in the heating and ventilating units, which shall on a fall in temperature below 35˚F., shut down its respective supply fan and close the outdoor air damper. Case of instrument shall be located outside of supply unit, within 10 feet of supply fan motor.

B. For systems with return air fans, on fan shut down, the return fan shall continue running or shall start, if not running.

2.24 PRESSURE SENSORS

A. Differential air pressure, static pressure and velocity pressure sensors shall be furnished by Modus, Air Monitor or equivalent.

B. Liquid, water or steam pressure sensing shall be furnished by Rosemount, Robinson Halpern or equivalent.

C. Pressure switches shall be furnished by United Electric, Dwyer or equivalent.

D. Air Differential Pressure Sensors

1. General: Pressure transducers shall be either diaphragm or strain gauge types.

2. Applications: Duct static pressure, filter DP, fan DP, air flow VP, etc.
3. Provide the smallest range feasible for the application. Provide zero and span adjustments.
4. Accuracy: Plus or minus 1% of full scale for static and 0.25% for air velocity.
5. Acceptable Manufacturers:

    a. Filter DP: Dwyer
    b. General and Static Pressure: Mamac, Setra, Veris Industries
    c. Air Flow: Air Monitor, Paragon

E. Liquid Differential Pressure Sensors:

1. Pressure transducers shall be either diaphragm or strain gauge types. Pressure transmitters shall gauge pressure in the form of a linear 4 to 20 mA or 0-10 VDC signal. Sensor shall be installed with a valve manifold and pressure/temperature test ports in lieu of pressure gauges. DP transmitter shall be rated for 150 PSIG static pressure. Wetted parts shall be stainless steel with a silicone fluid-filled diaphragm. Provide external span and zero adjustments.
2. Span shall be no greater than 2 times the working differential pressure of the system to allow the highest possible resolution.
3. Accuracy: 1% accuracy over the entire span.
4. Repeatability: Plus or minus 0.5% at maximum span.
5. Transmitters shall have a three-valve manifold for venting, draining, and calibration.
6. Acceptable Manufacturers:

    a. Gauge and Differential Pressure: Mamac, Setra, Veris Industries.

F. Air Differential Pressure Switches:

1. Cleveland Controls, Inc., products shall be used. The switches shall be installed in accordance with the manufacturer's installation instructions. All switches shall be mounted in accessible and, to the extent possible, vibration-free locations (i.e., not on duct work).

G. Liquid Differential Pressure Switches:

1. Barksdale Model EPD1HAA40 or Penn P74 differential pressure switches shall be provided when pressure sensing is required to determine status. All switches shall be mounted in accessible and, to the extent possible, vibration-free locations.
2. Do not use differential pressure switches for run status on pumps. Current switches shall be used on constant volume pumps and drive contacts shall be used for pumps with VFDs.

2.25 FLOW SENSORS

A. Differential pressure flow meters shall be furnished by Annubar or equivalent.

B. Vortex flow meters shall be furnished by EMCO or equivalent.

C. Flow sensors shall be carefully placed to ensure flow profiles that are required for accurate flow sensing. Designs shall specifically indicate the location of the sensors and indicate the length of unobstructed duct or pipe upstream and downstream from the sensor.

D. Water flow sensors shall meet the requirements necessary for use for test and balance duty as defined in the BACS specifications.

2.26 DIGITAL SENSORS

A. All digital inputs will be provided by dry contacts. The contacts will be wired normally open or normally closed as required.

B. Motor status (pumps, fans, etc.) by current sensing switch shall use Neilsen-Kuljian current-operated switch.

C. Pump flow status by differential water pressure shall use Penn P74 or equivalent.

D. Fan status by differential pressure shall be Dwyer or equivalent.

2.27 POWER SENSORS (CURRENT, KW, KWH)

A. Chiller amps shall be sensed by current transducers. The range of operation shall be from zero to a value not more than 50% of FLA. Use Ohio Semitronics CT-E series or equivalent.

B. Utility metered or submetered KWH or KW shall be sensed by a pulse producing transducer.

C. Current Switches (CS) for Constant Speed Motors:

1. CS shall be provided for status indication of constant speed motors.
2. Switch shall indicate loss of status when current falls below an adjustable trip point.
3. CS shall include LED indication of status.
4. Acceptable Manufacturer: Veris Industries (H708/ H908 series).

D. Current Switches for Variable Speed Motors:

1. Typically, status indication that indicates VSD or bypass operation shall be derived from contacts on the VSD. The VSD must be specified to include this option.
2. Otherwise, a current switch shall be provided for status indication. The switch shall be microprocessor based and suitable for use on a VSD.
3. Self-adjusting trip setpoint.
4. Factory programmed to detect belt loss undercurrent conditions.
5. CS shall include LED indication of status.
6. Acceptable Manufacturer: Hawkeye.

2.28 KW/KWH TRANSDUCER

A. The meter shall be capable of measuring true power demand (kW) and consumption (kWH). Output to BMS shall be via BACNET interface card.

B. The meter shall be capable of providing a field selectable pulse rate output of 1, 0.5, 0.1, or 0.05 pulses per (kWH).

C. The transducer shall receive its current inputs from safe current transformers that provide a 0-10 V output proportional to the primary current flowing in the sensed load.

D. The current transformers shall be accurate to +/- 0.5% from 1% to 100% of the rated current.

E. The voltage range shall be field selectable from 120 to 600 VAC.

F. The meter shall be accurate to +/-0.5% of the reading over a -15˚ to 40˚ C range.

G. The meter shall detect phase loss, or a low voltage situation, and provide an N.C., optically isolated FET (100 ma @ 24 VAC/DC) alarm output.

H. The transducer shall have an adjustable low voltage threshold trip point from 75-95% of the rated power of the monitored load.

I. The meter shall be mounted inside a Nema 1 enclosure.

J. The meter shall have an LCD meter mounted in the Nema 1 enclosure to display demand (kW) and consumption (kWH).

K. The meter shall be Veris Industries series H8100. Exact model number and accessories shall be matched to the characteristics of the system being metered.

2.29 CARBON MONOXIDE SENSOR

A. Carbon Monoxide Sensor shall be 3M Model CM-6, 0 to 200 PPM, 4 to 20 mA analog output.

B. Provide C.O. sensor in all rooms with combustion equipment.

C. Installation shall be per manufacturer's recommendations.

2.30 CARBON DIOXIDE SENSOR

A. Carbon Dioxide Sensor shall be Kele & Associates Model BA/AQS, 0 to 100% measuring range, 4 to 20 mA analog output.

B. Provide CO_2 sensor for all system specified, in all rooms or zones required to be measured or duct mounted for systems specified.

C. Application: Demand controlled ventilation of high density occupancy spaces, such as auditoriums, classrooms, lecture rooms, and conference rooms.

D. Acceptable Manufacturer: Vaisala

2.31 OCCUPANCY SENSORS

A. Single mode infrared sensors, with a minimum of two sensors per laboratory area, shall be used to establish occupancy/unoccupancy intervals. Schemes that utilize Time-of-Day (TOD), light switches and/or manual switches to establish lab occupancy shall be avoided. An unoccupied laboratory will be defined as having no people present in the room for a specified period of time (30 min. adjustable).

B. Occupancy sensors used in labs, classrooms, offices, and comparable spaces shall be Watt Stopper Model # CI-24 ceiling-mounted, 24VAC, passive infrared occupancy sensors. No substitutions considered.

C. Occupancy sensors used in auditoriums and comparable spaces shall be Watt Stopper Model # DT-200 wall-mounted, 24VAC, dual technology (passive infrared and ultrasonic) occupancy sensors. No substitutions considered.

D. Install no less than two occupancy sensors per space in laboratory spaces.

E. Occupancy sensors shall be installed in quantities such that unobstructed coverage of the entire space is provided.

2.32 METERING

A. Temperature and flow metering points are to be as shown on Drawings.

B. Geothermal/Condenser water BTU metering includes a flow meter, two temperature sensors, and a BTU processor. Basis of design shall use an electromagnetic meter. Acceptable manufacturers and models shall be as follows:

1. Basis of Design: Siemens Sitrans MAG 3100 (electromagnetic).
2. Alternate: Flexim FLUXUS ADM 7407 (ultrasonic).

C. Temperature sensors associated with the chilled water meter shall be Resistance Temperature Device (RTD) as manufactured by JMS Southeast, Inc. Model 3X(X=3TF3)SBK6BZZ312ZWZ2AX(X=Fully Potted). Probe shall have date of manufacture stamped on the surface. Thermowells shall be JMS model 51AT2CUK ½ inch step shank, 316 stainless steel, 0.260 bore sized to insert a minimum of 1/3 pipe diameter into flow stream. The junction box shall be a 2 x 4 handy box connected to the thermowell with CPVC nipples from the well to the head. Terminal connections shall be to a termination strip on the back of the handy box so probe can be removed through the front with the handy box cover removed. Provide a spare test well (identical to the sensing well) with brass cap and chain at all sensor locations.

D. The flow meter and temperature sensors shall be coupled to a BTU meter flow processor “FP93” as manufactured by EMCO. The flow processor shall be connected to the BMS via Ethernet.

E. If more than one building loop, or sub meters are required in a single building, multiple FP93 meters shall be connected to the BMS via Ethernet.

F. Do not disconnect existing chilled water metering until new metering or communications are in place.

2.33 DEWPOINT SENSORS

A. Units shall be suitable for duct, wall (room) or outdoor mounting with digital display. Sensors shall be two-wire transmitters utilizing bulk polymer resistance change or thin film capacitance change. Units shall produce linear continuous output of 4-20 mA for dew point temperature (°F). Sensors shall have the following minimum performance and application criteria:

1. Accuracy: +/- 1.8°F.
2. Sensor Operating Range: As required by the application.
3. Long Term Stability: Less than 1% drift per year.

B. Acceptable Manufacturers:

1. Vaisala

2.34 AIRFLOW SENSORS

A. Flow sensors shall be carefully placed to ensure flow profiles that are required for accurate flow sensing. Designs shall specifically indicate the location of the sensors and indicate the length of unobstructed duct or pipe upstream and downstream from the sensor.

B. Laboratory Air Terminal Flow Tracking: The standard manufacturer transducer typically supplied with conventional air terminals are not acceptable for use in a wet laboratory application requiring devices with a higher speed of response. The transducer shall be upgraded to a device with the following specifications:

1. Accuracy: +/- 0.25%.
2. Stability: +/- 0.5% of full scale per year or less.
3. Auto-zero capability by venting ports to atmosphere.
4. Acceptable Manufacturers: Air Monitor, Paragon.

C. Air Handling Unit, VAV box mounted, and Duct Airflow Monitoring: A pitot-tube averaging grid of a material compatible with the environment is to be used. The use of fan inlet grids are preferable where possible to measure fan flow. Fan inlet grids shall be provided by the fan vendor and shall not block or affect fan efficiency. The transducer shall have the following specifications:

1. Accuracy: +/- 0.25%.
2. Stability: +/- 0.5% of full scale per year or less.
3. Auto-zero capability by venting ports to atmosphere.
4. Acceptable Manufacturers: Air Monitor, Paragon.

2.35 CONDENSATE SENSORS

A. Application: Moisture sensing on chilled water supply systems to terminal chilled beam devices.

B. Acceptable Manufacturers and Model Numbers:

1. Siemens QXA 2000
2. Sauter EGH 102
3. Honeywell H7018A1003

2.36 CONTROL VALVES

A. Valves shall be applicable for the rated pressure and temperature service. Close off pressures must be determined in concert with the actuators and valves shall be provided to close off against extreme anticipated conditions.

B. Modulating valves shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. “Split ranging” of heating and cooling valves controlled by the BACS is not acceptable. A separate output from the BACS shall be provided for all control valves. General guidelines are indicated below. When the selection criteria indicated below are not met, flow characteristic analyses shall be submitted to demonstrate reasonable correlation between stroke and flow. Actuator positioning requirements are as follows for each type, if used:

1. Electric Input: 4-20 mA or 0-10 VDC
2. Electrically piloted valves shall have a pneumatic actuator with positioner

C. The BMS output to modulating valves shall be analog. In addition:

1. Terminal reheat valves shall be proportional
2. Fan coils and similar terminal device valves shall be proportional
3. Radiation valves shall be two-position or proportional
4. Unit heaters shall be two-position line voltage thermostats.

D. Two-way Pressure Independent Control Valves: Pressure independent control valves can be utilized, but are not required. If used, they shall be two-way pressure independent control valves such that balancing of the valves and associated branch piping shall not be required. In addition:

1. The absolute flow accuracy through the valve shall be:
   a. +/- 5% due to system pressure fluctuations across the valve in the selected operating range
   b. +/- 5% due to manufacturing tolerances
2. The control signal shall be modulating as described above
3. The valves shall accurately control the flow from 0% to 100% full rated flow
4. A minimum of 2 PSI shall be required to operate the valve pressure independently

5. The valves shall require no maintenance and shall not include replaceable cartridges
6. The valves shall be available with optional pressure/temperature ports to allow flow verification.

2.37 DAMPER ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or two-position action and adequate close off rating as required.

B. For AHU/Duct mounted dampers:

1. Actuators shall be electronic.
2. Standard Electronic Actuators: Shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have a positive positioning circuit and selectable inputs. Full stroke shall be within 90 seconds. Where fail positions are required, provide spring return on the actuator with adequate close off force.
3. Acceptable Manufacturers:
   a. Belimo

C. For terminal unit dampers:

1. Standard Electronic Actuators: Shall be designed for a minimum of 60,000 full cycles at full torque. Provide stroke indicator. Output to modulating damper actuators shall be analog.
2. Fast Acting Electronic Actuators: Provide fast acting electronic actuators for VAV terminals on fume hood and associated tracking zone dampers. These actuators shall move full stroke in less than one second. Output to modulating dampers actuators shall be analog.

2.38 CONTROL PANELS

A. Enclosures

1. Enclosures located in mechanical rooms shall be NEMA 4.
2. Enclosures located in relatively dust free and dry spaces may be NEMA 1.
3. Enclosures located outside or on the roof shall be NEMA 4X.
4. Enclosures shall be mounted on walls or free-standing supports.

B. Power Supplies

1. The Contractor shall provide a regulated, protected power supply as required with the ability to produce at least 33% more current than required by the transmitters and controls being installed. Output regulation shall be less than 0.5mV. There shall be no overshoot on turn on or off. Operating temperature shall be -20 to +70ºC.
2. The BACS Contractor shall certify, in writing, at the time of shop drawing submittal that the DDC equipment provided will not cause, as a result of its operation, either directly or indirectly, electrical interference to be induced into the building's electrical power systems.
3. Class II transformers shall be used.

C. Panel Fabrication

1. The Contractor shall size the panel such that no more than 80% of the surface of the enclosure back plate is used.
2. Plastic wire way (e.g., Panduit) shall be used to organize all wiring in the panel.
3. Sufficient wire way shall be provided in the panel such that it is filled no more than 80% capacity.
4. Panel layout and construction shall be neat and professional.

5. All controllers, wiring, and components in the panels shall be labeled. All labeling shall match the reference numbers on the cabinet drawings that shall be provided for each panel.
6. Label the power source and circuit number for each panel.

PART 3 – EXECUTION

3.1 FUNCTION

A. Provide all components necessary to achieve the Sequences of Operation listed in Part IV and any additional industry standard functions normally required of a first class BMS/ATC installation.

B. This division shall provide a project manager who shall, as a part of his duties, be responsible for the following activities:

1. Coordination between this Contractor and all other trades, Owner, local authorities and the design team.
2. Scheduling of manpower, material delivery, equipment installation and checkout.
3. Maintenance of construction records such as project scheduling, manpower planning, and as-built drawings for project coordination and as-built drawings.

3.2 INSTALLATION METHODS

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Electrical sections of these specifications.

B. The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices.

C. Control Wiring:

1. Number-code or color-code conductors appropriately for future identification and servicing of control system.
2. All line voltage power wiring required because of substitution of low voltage power wiring equipment specified in this division, shall be provided by this division.
3. Comply with the applicable requirements of Division 26 for the installation of electrical wiring incidental to the temperature control system.
4. Comply with the applicable requirements of National Electrical, New York City Building Code, and Building Code for the installation of electrical wiring incidental to the temperature control system.
5. Control wiring shall be run in conduit in accordance with the electrical sections of this specification.
6. Conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than ½" trade size be allowed. Where conductors are not in conduit, cable rated for use in return air plenums shall be used.
7. BMS/ATC division shall provide all control transformers and all control wiring (including low voltage actuator power wiring). This division shall also provide power wiring from the control circuits to the transformer locations and all other temperature control devices requiring power wiring. Electrical Contractor shall furnish appropriate control circuits (both normal and emergency) in suitable panelboards located throughout the project.
8. BMS/ATC division shall provide UL listed surge protectors for all control circuits upstream of control transformers.

D. Equipment installed under other divisions of the specifications:

1. Furnish dampers, valves, temperature sensor wells, flow switches and other equipment to Installers at proper time.

2. Provide installation instructions.

E. Adjust low-leakage dampers so all gaskets and seals are properly compressed.

F. Provide outside air and relative humidity sensors at each outside air intake louvers for air handlers.

G. Unless specifically indicated on plans, do not install wall mounted thermostat or temperature sensor on exterior wall. For thermostats or temperature sensors located on an exterior wall, provide insulated base behind device.

H. The access panels or doors shall be a minimum size of 18 x 18 inches.

I. Devices (i.e., sensors, meters, instruments, etc.) that are resettable must be installed in a readily accessible location (e.g., the device must be accessible at floor level without the use of a ladder). No device shall require shutting down a building system for calibration.

J. Devices that are installed in an exposed location (i.e., not mounted within a cabinet) must be suitable for such installations (e.g., do not install a device that is intended to be installed in a cabinet in an exposed location).

K. Software and Hardware Updates - At the end of the first six months, and during the second six months, the Controls Contractor shall update the equipment and any controllers, servers, workstations and HMI Web servers with the latest modifications and improvements in software, firmware, and hardware that the manufacturer may have incorporated in the furnished equipment.

L. Control panels and enclosures housing the controllers shall be coordinated to the extent possible, to share vertical and horizontal wire-ways to facilitate and minimize the cost of home-runs to terminal equipment. All penetration of the controller enclosure within mechanical rooms shall be from the bottom of the enclosure with wireway and conduit stubs from the wireway up to the panel.

M. Control panels shall be located in equipment rooms, where practicable, and in locations maintaining ambient conditions between 50 and 90°F and 10 to 85% relative humidity. Control panels located in areas where conditions are outside of these ranges shall have enclosures outfitted with heating or cooling devices to provide the proper environmental conditions. Hoffman style enclosures with removable back plates and keyed, hinged covers shall be used. Enclosures shall be rated NEMA 4 when located in mechanical spaces and NEMA 1 when located in occupied spaces. Provide enclosures with key lockable doors.

N. All transformers and power supplies shall be mounted outside of the central panel.

O. Controller Installation Requirements

1. Building and system-level controllers shall be capable of operating independently, in stand-alone fashion, with no communication to other devices on the network while performing their monitoring and control routines using programs and operating parameters stored in the controllers' memory.

2. All points and functions that make up a functional system (typically that shown on one control schematic) shall be included in one controller to qualify for this stand-alone functionality. Where control sequences depend on global variables such as OAT, the controller shall have the capability of either using the last value.

3. Controller software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the failure mode requirements defined on the drawings. In this state it shall issue an alarm.

4. Controllers must include sufficient memory for all required operation and all required trending, when trending is buffered in the controller. Where control system operation is hindered by the shortage of memory,

contractor shall, at no cost to the Owner, either upgrade the memory or provide multiple controllers. The mix of points for multiple controllers shall not violate the stand-alone requirements. Volatile memory is required to be backed up in the event of power loss. Software stored in non-volatile memory will not have to be downloaded from the central server after an interruption of power occurs.

5. Controllers used for time-scheduled operations must be equipped with a battery backed internal real-time clock function to provide a time base for implementing time-dependent programs. Provision shall be made for the routine updating of the controllers' clocks via a time master.

6. Resumption of power after an outage shall cause the controllers to automatically restart and establish communications as needed by their applications. Controller shutdown based on a self-diagnosed failure in the power supply, hardware, or software must set each piece of controlled equipment to a predetermined failure mode.

7. Controllers shall be powered from the most reliable source that powers any of the systems it serves. In the situation where a controller will be required to continuously collect data to be transmitted to a workstation, or where it monitors critical recovery information such as the presence of emergency power, it may be necessary to provide a UPS for the controller as well as any critical sensors. Where panels are provided with a different power source as the equipment (such as when the panel is on a UPS), the panel shall be provided with a means of monitoring the power source to the controlled equipment. This can be a dedicated power monitor or a value coming from transfer switch contacts.

P. Fabrication

1. The Contractor shall size the panel such that no more than 80% of the surface of the enclosure back plate is used.
2. Plastic wire way (e.g., Panduit) shall be used to organize all wiring in the panel.
3. Sufficient wire way shall be provided in the panel such that it is filled no more than 80% capacity.
4. Panel layout and construction shall be neat and professional.
5. All controllers, wiring, and components in the panels shall be labeled. All labeling shall match the reference numbers on the cabinet drawings that shall be provided for each panel.
6. Label the power source and circuit number for each panel.

3.3 IDENTIFICATION

A. Devices Inside Panels: Either of the following:
1. Engraved labels.
2. Lettered in permanent ink with felt tip marker.

B. Exposed Devices: Engraved labels.

C. Location: On the body of the device or on the surface to which it is mounted.
1. Do not put identification on removable covers.

D. Label each remotely mounted control panel as to the device it controls.

3.4 OPERATING AMBIENT CONDITIONS

A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions from -40°F to 155°F. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.

3.5 OWNER TRAINING

A. The BAS/ATC contractor shall provide 4 copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control and Building Automation System supplied. This contractor shall instruct the owner's designated representatives in these procedures during the startup and test period. The owner training shall consist of a minimum of three (3) 8 hour instruction periods scheduled by the owner over the first 12 months of system operation. The training shall be scheduled during normal working hours.

B. Follow up training shall be provided under this Division for two (2) eight hour instruction periods at six months and twelve months after building acceptance.

C. Provide minimum 40 classroom hours of factory training in programming and use of the BMS/ATC system for each of two people (designated by Owner). Provide room and board for trainees class during this period if factory is located more than 30 miles from the project. Provide this training no more than eighteen months after building acceptance.

D. Upon completion of the work and acceptance by the Owner, factory representatives of the control manufacturer shall provide instruction to the Owner's operating personnel who have responsibility for the mechanical systems and controls installed by the contractor. The amount of training that is provided shall match the size of the project (e.g., no less than twenty-four hours).

E. The contractor shall make available to the Owner regular, scheduled training courses for ongoing training of the Owner's operating personnel. Programs shall include hardware- and software-oriented courses as well as energy conservation and management courses.

F. In addition to the normal training listed above, all vendors will be required to provide two weeks of training at the BACS manufacturer's training facility for four people. This training only needs to be provided once for a particular set of installed BACS products. If a contractor has provided this training previously (on a previous project or directly with the Owner) then the additional training does not need to be provided again.

3.6 CALIBRATION AND ADJUSTMENTS

A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the ATC and BAS system under warranty below.

3.7 OPERATION BY OWNER

A. Owner may require operation of part of the system prior to final acceptance. Operation is not to be construed as acceptance of work.

3.8 ACCEPTANCE PROCEDURE

A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative.

B. Upon completion of the calibration, Contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Test shall include a 100% point to point check-out of all BMS devices to confirm proper response to manual input. Installer shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the Owner's representative or Architect shall be performed.

1. If more than two of the first 10 devices tested, or more than 10%of the first 20 or more devices tested, fail to operate properly, the test shall be discontinued.
2. Additional testing, after corrections are made, shall be done at the Installer's expense.

C. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

D. Field Equipment Test Procedures: DDC Zone and Local Controllers shall be demonstrated via a functional end-to-end test as follows:

1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operations verified. (Point - to- Point Checkout)
2. All analog input channels shall be verified for proper operation.
3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.

E. Workstation Test Procedures: The System Workstation test procedures shall be as follows:

1. Communication with each DDC Zone and Local Controller shall be demonstrated.
2. Operator commands will be explained and demonstrated.
3. Control sequences shall be demonstrated for proper operation.
4. All available system reports and logs shall be demonstrated at the System Workstation.
5. Correct system start-up and shutdown procedures shall be demonstrated.
6. All controllers shall be demonstrated to operate in standalone mode.

F. Acceptance Test of Mechanical Systems

1. Perform at least two (2) operational tests of the entire mechanical system as described in the specifications.
2. Give each element of the system an operating test of not less than 48 hours' duration to demonstrate to the satisfaction of the Architect that the control system is functioning properly and that the system is capable of producing the required environmental conditions. During this test, operate the system entirely on automatic control and take periodic readings of the inside and outside wet and dry bulb temperatures. Obtain wet and dry bulb temperatures with a recording thermometer-hygrometer. Conduct tests with outside temperature and humidity conditions as near design conditions as practical.
3. Winter acceptance test shall be conducted when outside temperatures are at or near 10^0F, summer acceptance test shall be conducted when outside temperatures are at or near 90^0F db.
4. Conduct tests during summer and winter outdoor temperature extremes as specified above. Notify Owner seven (7) days in advance of proposed tests.
5. Record temperature and humidity at an exterior and interior location for each system as designated by the Engineer at least once every hour for 48 hours during tests.
6. Submit a report detailing the following:
    a. Instrument used:
        1) Most recent calibration date.
    b. Date of tests.
    c. Description of test apparatus locations and methods.
    d. Results of tests.
    e. Any abnormal usage of the building or abnormal system characteristics observed during the course of the test.

3.9 COMMISSIONING

A. The BACS shall be fully commissioned. All acceptance testing, documentation, and training shall be required.
B. The BACS contractor's responsibilities for commissioning and check-out include the following:

1. Provide all logic, graphics, and trends for review prior to the start of field commissioning activities.
2. Provide a complete calibration and operational check for each individual point and function contained within the BACS.
3. Conduct the checkout with the use of point/function log sheets to be prepared by the subcontractor. The Owner shall approve the log sheet format.
4. Submit log sheets to the Owner prior to the commencement of any final acceptance testing.
5. Certify, in writing, to the Owner prior to the commencement of final acceptance testing that all components of the BACS system are functioning as per the requirements of the contract documents.
6. Provide to the Owner as-built drawings and documentation at least four (4) weeks prior to the commencement of any final BACS acceptance testing.
7. The BACS contractor shall issue a report upon project completion stating that the system is complete, has been adjusted, and has had all hardware and software functions verified, that all analog control loops are tuned, and is operating in accordance with the specifications. Any deviations from specified settings or operations necessitated during system adjustment shall be specifically noted.
8. The BACS contractor shall check out the installation with the Owner and Engineer. The checkout shall consist of verifying the ability of the BACS to communicate with the central EMCS system, verifying the calibration of each sensor and/or transmitter, and verifying the operation of each control point.
9. All software processes shall be thoroughly demonstrated to the Owner. Alarm conditions shall be simulated for conformance. Analog control points shall be exercised through their entire range. All control interlocks and sequences shall be completely verified. The checkout shall be a thorough and exhaustive review of the installation to assure proper operation of the total system.

3.10 RECORD DOCUMENTS

A. Electronic Media As-Built Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply complete 11X17 hard copy as-built drawing sets, together with CD's to the owner. Provide (4) copies of O & M Manuals.

B. Operation and Maintenance Manuals: Submit Operation and Maintenance manuals. Include the following in each manual:

1. BMS/ATC information for insertion into the Manufacturer's catalog data and specifications on all sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
2. An Operator's Manual which will include detailed instructions for all operations of the system.
3. An Operator's Reference Table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
4. A Programmer's Manual which will include all information necessary to perform programming functions.
5. A language manual which will include a detailed description of the language used and all routines used by the system.
6. Flow charts of the control software programs utilized in the Temperature Control System.
7. Flow charts of the custom software programs utilized in the Temperature Control System.
8. Complete program listing file and parameter listing file for all programs.
9. A copy of the warranty.
10. Operating and maintenance cautions and instructions.
11. Recommended spare parts list.
12. Twenty-four (24) hour service phone number and point of contact.
13. Controlled Schematic Drawings.

14. Detailed written sequences of operation.
15. Valve, damper, and laboratory airflow devices schedules.
16. Floor Plans.
17. Wiring Diagrams.
18. Sample Graphics and Trends.

3.11 WARRANTY

A. All BAS/ATC devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance by the owner. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the owner. Factory authorized warranty service shall be available within 50 miles of jobsite.

B. Except as otherwise specified, the Contractor shall warrant and guarantee all work against defects in materials, equipment, and workmanship for a period of one (1) year from the date of acceptance of the work as evidenced by a resolution to that effect by the Owner, and for that period of time noted in special or extended warranties.

C. The period of one (1) year shall be extended with respect to portions of the work first performed after substantial completion by the period of time between substantial completion and the actual performance of the work.

D. The Contractor shall provide all recommended preventative maintenance of the materials, equipment, and workmanship as necessary and as described in the operating and maintenance manuals during the warranty period. In addition, the Contractor shall provide two (2) semi-annual service visits (i.e., one visit during the peak cooling season and one visit during the peak heating season) to test and evaluate the performance of the equipment. The Contractor shall provide a written report of the test and evaluation results. The service visits shall include, but not be limited to:

1. Checking and, if necessary, correcting the calibration of the sensors, transducers, and transmitters for airflow, liquid flow, pressure, temperature, and humidity.
2. Checking and, if necessary, correcting the operation of the dampers and damper actuators.
3. Checking and, if necessary, correcting the operation (i.e., monitoring and command) of the system points.

E. Software and Hardware Updates: At the end of the first six months after acceptance, and during the subsequent six month period, the BACS contractor shall update the equipment and any controllers, servers, workstations and HMI web servers with the latest modification and improvements in software, firmware, and hardware that the manufacturer may have incorporated in the furnished equipment.

3.12 INSPECTION

A. Examine location where controls and equipment are to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

1. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.13 INSTALLATION

A. Install in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with the work as necessary to interface installation of equipment with other components of systems.

3.14 FIELD QUALITY CONTROL

A. Upon completion of installation of the automatic temperature control system and after motors have been energized with normal power source, test system to demonstrate compliance with requirement. When possible, field correct malfunctioning controls then retest to demonstrate compliance. Replace controls which cannot be satisfactorily corrected. Refer to Testing and Balancing Section of this specification.

3.15 SERVICE

A. After completion of the control system installation, the control manufacturer shall regulate and adjust all temperature sensors, control valves, damper motors, etc., and place in complete operating condition, subject to the approval of the Architect. The control contractor shall provide two complete instruction manuals, in addition to any other manuals called for in this specification, to the Owner's operating personnel. The manual shall include the function and operation of all control components on this project. Complete instructions shall be given to the operating personnel. There shall be two day's instruction given for Winter cycle and two day's instruction for Summer cycle operation.

3.16 SUBMISSION REQUIREMENTS

A. Control Schematics

1. BACS legend and abbreviations.
2. BACS one-line Architecture diagram.
3. Point names and types.
4. Normal position of output devices.
5. Setpoints.
6. Point addresses and device ranges.
7. Bill of materials listing all devices and manufacturer numbers.

B. Point and Alarm List

1. Point type (AI, BI, AO, BO, BV, AV)
2. Specific input points that must be able to be put in test mode to facilitate commissioning.
3. Listing, for each point, of any associated alarms. Control loops shall an adjustable setpoint deviation alarm based upon error and time. The alarm parameters shall be the state the point is in to cause a particular including whether the source system is also enabled. Examples of points in this list are as follows:
   a. Supply air temperature (AI) +/- 4°F from setpoint for 30 minutes.
   b. Space air temperature (AI) +/- 4°F from setpoint for 30 minutes, baseboard radiation heating system is enabled.
4. Listing, for each point, of its trending and scheduling requirements.
5. Listing of whether the point is to be included on the BACS graphics.
6. Point address.

C. Sequences of Operation

1. Sequences in all modes of operation: on, off, occupied, unoccupied, warm-up, cool-down, night setback, summer, winter, economizer, etc.
2. Sequences shall be organized into logical groupings including: run/stop, pressure, economizer, coils, discharge air, humidification, dehumidification, hydronic temperature, etc.
3. Detailed steps during mode switches.
4. Details of operation during and after a power outage. Loss of status associated with power outages are not to be indicated as failures with a subsequent alarm or lock out.
5. Specific direction on failure scenarios for loss of proof and all safety device trips.
6. Setpoints, trip points, and ranges.
7. Fire/smoke control system interfaces.

8. Schedule of operation, including Vassar holidays and breaks.
9. Fire alarm panel interlocks and special operating modes.

D. Valve Schedule

1. Manufacturer and Model Number.
2. Valve Size, valve type, and CV Rating.
3. Actuator and Model Number.
4. Type (2-way/3-way, spring return/non spring return, etc.)
5. Flow and pressure drop at design maximum flow.
6. Normal positions.
7. Position of valve at design conditions.
8. Close off rating.
9. Valve characteristic =(i.e., equal percentage, linear, etc.).
10. Valve turndown.
11. Design Flow
12. Design controlled circuit pressure differential range (BACS vendor only, coordinated with the submittals).

E. Damper Schedule

1. Manufacturer and Model Number.
2. System Served.
3. Damper Size and Leakage Class.
4. Actuator and Model Number, Pilot (Y/N), Range and Mounting Position.
5. Size and Type (parallel blade/opposed blade, etc.).
6. Design flow and pressure drop.
7. Normal positions.

F. The BACS vendor shall submit manufacturer's technical product data for each control device, panel, controller, and accessory furnished indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation, start-up, calibration, and maintenance instructions as well as all cable and tubing requirements.

G. System architecture one-line diagram indicating schematic location of all controllers, workstations, LAN interface devices, gateways, etc. The ACS vendor shall indicate address and type for each control unit; as well as indicate physical media, protocol, communication speed, and type of each LAN.

H. Set of floor plans with all controllers/control panels, sensors, operator workstations, interface devices, UPS's, etc., located and identified. The BACS vendor shall indicate all network components (repeaters, routers, etc.); network wiring shall be shown and identified on the floor plan drawings.

I. Detailed Wiring Diagrams: The BACS vendor shall include detailed wiring. Indicate all required electrical wiring. Wiring diagrams shall include both ladder logic type diagrams for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on the system schematic. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. All wiring of related components that make up a system shall be grouped together in one diagram (e.g., all wiring diagrams for the components and devices on a particular AHU shall be shown on one drawing. The supply fan components and devices should not be shown separate from return fan components and devices, etc.).

J. Operation and Maintenance Materials: The BACS vendor shall provide Operation and Maintenance (O&M) materials generally in concert with training. O&M materials shall include the following:

1. Maintenance instructions and spare parts list for each type of control device, control unit, and accessory.
2. BACS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripheral.
3. BACS Programming Manuals for each controller type and for all workstation software.
4. All information provided during the submittal phase; updated with as-built information. As-built panel drawings shall also be included as part of the O&M manual process. The drawings that are located in each panel shall incorporate all the systems controlled from that particular panel. The drawings shall include the system schematic and detailed panel wiring diagram. Also included (typically noted on the system schematic diagrams) should be the specific locations of any remote devices such as remote static pressure sensors, differential pressure sensors, etc.
5. Each control panel on the project shall include an as-built hard copy of all drawings and documentation associated with that panel and its field devices. This documentation shall be provided in a plastic protective pocket mounted inside the panel door.
6. The final as-built controls drawings (PDF) shall also be accessible via the web based graphics.

PART4 – SEQUENCE OF OPERATION

4.1 GENERAL

A. BMS/ATC Contractor shall design, install, program, test, commission and demonstrate a complete and fully functional system capable of meeting the Sequences of Operation detailed below. Provide additional control points and functions as required, even if not specifically called for, if normally considered necessary for a BMS/ATC installation of the size and complexity of this project or if required to implement control sequence.

B. Listed items of equipment shall be individually controlled by standalone controller. Each controller shall serve only one individual unit. The unit controller shall be supplied by the BMS Contractor and may be furnished to the equipment supplier for factory mounting. The cost to mount, calibrate, program and test the controller and actuator shall be coordinated prior to bid day and included in the BMS price.

1. VAV Box.
2. Heat Pump Unit.
3. Air Handling Unit.
4. Rooftop Unit.
5. Heat Exchangers.
6. Geothermal System.
7. Solar thermal system
8. Solar photovoltaic system

C. Multiple units may be controlled by individual standalone controllers for all other control points.

D. Sensor and transducer installation, control power and wiring and communications wiring shall be provided under this division by BMS/ATC Contractor.

E. Refer to the Systems Points List at the end of this division and equipment schedules on the drawings for required control inputs and outputs for each item of equipment listed in the Sequence of Operation.

F. Where control sequences depend on global variables such as outside air temperature, the controller shall have the capability of either using the last value or a default value.

1. All points and functions required to control an air handler with all directly associated supply, return, and exhaust fans. This excludes the terminals that may be associated with that air handler. Values that may be

received across the network include humidity, emergency power source indication, terminal based reset parameters, and smoke modes.

2. All points associated with the supply side of a hydronic system such as pumps, flow meters, temperature and pressure sensors, proof indications, valves etc. This excludes the terminals on that hydronic system. Values that may be received across the network include outside air temperature and humidity, emergency power source indication, and terminal based reset parameters.
3. All points and functions required to control one terminal system including dampers, valves, flow meters, temperature and humidity sensors, etc. This does not include the scheduling period or any outside air that may be necessary for control.

G. Trending: To support commissioning and building data mining, the BACS shall be capable of trending and archiving all points on building- and system-level controllers at a minimum of 15 minute intervals. The BACS shall also have the capability of trending at least five points on each field-level controller at an interval of 15 minutes. The trend data shall be uploaded to a central database as needed to prevent buffer overflow in the controller. Controller memory capability, network architecture, and communications bandwidth shall be designed to account for this trending. The BACS vendor shall provide control trends during start up and prior to functional performance testing of the systems. Reports shall be scheduled to output the data to a common format such as comma separated text, Microsoft formats such as Excel and Access, and portable database format. Trended data shall also be archived in an Owner-accessible SQL database.

H. Trend Graphs: Web-based software shall provide for displaying graphic plots of the trended values. The software shall support multiple scales, points and point types simultaneously. The BACS vendor shall configure these graphs in a logical manner for each system. Consult with the commissioning team members and project manager for required configuration. Provide a trend for every analog control loop that includes the setpoint, process variable, and control output.

I. Real-time Plotting: Software shall be provided for real time plotting/graphing of multiple values in user-defined time intervals. These graphs will typically be used in commissioning to observe loop responses and system reactions. The BACS vendor shall configure these graphs in a logical manner for each system. Consult with the commissioning team members and project manager for required configuration.

J. Web-based Graphics:

1. Floor Plan Screens.

    a. Provide floor plan screens for each floor and/or section of the building. Indicate the location of all equipment that is not located on the equipment room screens. Indicate the location of temperature sensors and VAV boxes associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHU's etc.) on the floor plan screens.
    b. Display the space temperature point adjacent to each temperature sensor symbol. Indicate room numbers as provided by Vassar University. Provide a graphic link from each zone and/or equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.
    c. Provide floor plan screens for each mechanical equipment room and, if mechanical equipment is situated there, the roof. Indicate the location of each item of mechanical equipment. Provide a link from each equipment symbol shown on the plan view screen to each corresponding mechanical system schematic graphic.
    d. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link the graphic building key plan to larger scale partial floor plans. Provide links from each larger scale floor plan graphic to the building key plan and to each of the other graphic floor plan screens.
    e. Provide a graphic site plan with links to and from each building graphic.

f. All points indicated on control details shall be displayed on graphic.

2. System Schematic Screens:

a. Provide graphics for each air handling and heat pump system. Indicate OA temperature and relative humidity, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down, etc.). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems, if they are not available in a single graphic.
b. Each I/O point in the project shall appear in at least one graphic. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc., as applicable. General layout of the system shall be schematically correct. I/O devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the cursor. Indicate all adjustable setpoints on the applicable system schematic graphic or, if space does not allow, on a supplemental linked setpoint screen. All outputs shall be represented in terms of percent open and include a pop-up link to the control logic.
c. Provide a system schematic graphic for each HVAC subsystem controlled.
d. Provide a graphic for each hydronic system.
e. Provide a graphic for each terminal unit. In addition to points associated with the unit, indicate mode of operation as applicable (i.e., normal occupied, unoccupied, warm-up, maximum heating, maximum cooling, etc.). Provide links between the applicable floor plan screen and this screen. Also provide links to the graphics representing the parent systems.
f. Link screens for heating and cooling system graphics to utility history reports showing current and monthly energy usage, demands, peak values, etc.
g. Link screens to all schedules and setpoints.

K. Alarm Programming: Alarms shall be “intelligent” based upon the algorithms in this section.

1. In general, alarm programming related to DDC controlled equipment should reside at the controller level along with the functional programming for equipment control.

a. Intrinsic alarming associated with AI, AV, BI or BV objects (or any of the other 23 BACnet objects that support intrinsic alarming) shall only be used where the alarm is valid regardless of the state of the associated equipment or where there is a ready means for automatically suppressing alarm generation when the associated equipment is operationally secured.
b. Alarm points shall be separate BACnet objects (e.g., BV or EEO) actuated by associated alarm programming.
c. Alarm objects shall have descriptive BACnet object names. BACnet alarm object names shall end in “Alarm”. For detailed information on proper point naming conventions, see Vassar University Facility Services, Design and Construction Standards, 230901 Building Automation and Control System Communications and Interoperability.
d. If it is necessary for the alarm to have latching functionality, the user shall be provided easy unlatching capability from within the DDC system if appropriate, taking into account equipment safety concerns. This is in addition to any local alarm reset.
e. Alarms designated for monitoring by EMCS shall be set up in the DDC system to report to the EMCS alarm server.

2. Analog Deviation Alarms: Analog deviation alarms shall be based upon the comparison between the controlled variable and the controlled variable setpoint (whether calculated or fixed).

a. When controlled variable deviates from setpoint above or below user adjustable high or low alarm thresholds, the alarm shall be activated.

b. High and low alarm threshold values shall have associated adjustable deadbands (hysteresis values) for alarm clearing conditions as the controlled variable falls below the high alarm threshold or rises above the low alarm threshold.
c. Alarm programming shall include user adjustable alarm delays for active equipment operation.
d. Alarm programming shall include startup delays to prevent nuisance alarms during equipment startup.
e. Analog deviation alarms shall be disabled if the associated equipment is operationally secured.

3. Analog High Limit Alarms: Analog high limit alarms shall be based upon the comparison between the controlled variable and a user adjustable high limit alarm value.

a. When controlled variable rises above the user adjustable high limit, the alarm shall be activated.
b. High alarm limit value shall have associated adjustable deadband (hysteresis value) for alarm clearing condition as the controlled variable falls below the high alarm limit.
c. Alarm programming shall include user adjustable alarm delays.
d. High limit alarms shall be disabled if the associated equipment is operationally secured, unless needed due to equipment safety considerations.

4. Analog Low Limit Alarms: Analog low limit alarms shall be based upon the comparison between the controlled variable and a user adjustable low limit alarm value.

a. When controlled variable falls below the user adjustable low limit, the alarm shall be activated.
b. Low alarm limit value shall have associated adjustable deadband (hysteresis value) for alarm clearing condition as the controlled variable rises above the low alarm limit.
c. Alarm programming shall include user adjustable alarm delays.
d. Low limit alarms shall be disabled if the associated equipment is operationally secured, unless needed due to equipment safety considerations.

5. Binary Run Status Alarms: Status alarms shall be based upon the comparison between run status and equipment command where applicable.

a. Alarm Status programming shall include user adjustable alarm delays.

6. Binary Alarming: Alarms shall be triggered upon associated BI changing state to the non-normal or alarm state.

a. Alarm Status programming shall include user adjustable alarm delays.
b. Binary alarms shall be disabled if the associated equipment is operationally secured, unless needed due to equipment safety considerations.

4.2 OCCUPANCY SCHEDULES

A. Scheduled Occupancies

1. Occupied during expected occupied period
2. Unoccupied during expected occupied period.
3. Occupied during expected unoccupied period.
4. Unoccupied during expected unoccupied period.

B. Unscheduled Occupancies

1. Vacant
2. Occupancy pending

3. Occupied within past 2 hours.

C. Each room or space shall be provided with an individual heating or cooling setpoint or may participate in global setpoint values for each occupancy condition.

D. Any device utilizing on/off control or scheduling shall be capable of being programmed to conform to any of these schedules.

4.3 BUILDING LEVEL

A. At a minimum, monitoring at the building level shall consist of the following points.

- Outside Environment:
  - Outside air temperature (OAT)
  - OA dewpoint
  - OA enthalpy (calculated)
- Geothermal System:
  - Water supply and return temperatures
  - Tons
- Sanitary Service:
  - Receiver hi-level alarm (if pumped)
- Electric Service:
  - Electricity use (kW), contact
- Emergency Electric Service:
  - Generator status
  - Generator alarm
  - Transfer switch position
- Sanitary Service:
  - Receiver hi-level alarm (if pumped)

B. When power returns, the systems in the building shall be restarted in priority of criticality with a slight timing delay between starts to minimize the inrush power requirements.

4.4 BACS REQUIREMENTS FOR ZONE LEVEL CONTROL

A. General

1. This section of the guideline defines general physical Input/Output (I/O) requirements, sequences, and by inference some degree of system requirements related to how the BACS is applied to zone level control.
2. As a minimum, all zones of control will require a space sensor.
3. Without exception, temperature sensors shall correlate with the controlled zone. In zones where both heating and cooling systems are designed, it is especially important to coordinate the heating and cooling control zones.
4. Override buttons provided with sensors shall as a minimum perform the following functions:
   a. Return the zone to occupied mode and enable the equipment that serves the zone (e.g., the central air handling unit and the zone VAV box). All other zones that are not occupied shall remain at unoccupied flow setpoints, as applicable.
   b. For single zone units, the AHU (or other terminal system) serving the zone shall start and run in the occupied mode.
5. Private offices shall also include space temperature adjustment and alphanumeric display with sensor.
6. Zone temperature control shall, unless indicated otherwise, include a 5 ˚F deadband between heating and cooling setpoints to minimize energy use and avoid "fighting."
7. In all cases, the heating and cooling within a zone must be coordinated to avoid simultaneous heating and cooling.

8. Generally, controllers serving zone terminal devices shall be field-level controllers fed from normal power. Tracking laboratories will require system level controllers fed from emergency power.
9. A comprehensive package of standard zone temperature control drawings, including control schematics, points and alarms list, and sequences of operation have been developed for zone HVAC systems typically used on the Vassar campus. These drawings exist to aid the consultant in designing building control systems to meet Vassar requirements. Where a drawing exists, a drawing reference will be included. Consult Vassar for deviation from these standards, and zone control systems not covered by these drawings.
10. Fail position on the systems that serve these standard environments will generally fail to either last condition/position or heating where there is a perimeter wall or some need for heating. Where there is not a need for heating, such as in an internal zone, systems shall fail to either last position/condition or to cooling.
11. Occupied, occupied setback, and unoccupied temperature setpoints shall be designated on the design control drawings. Occupied setback mode is used where a defined building occupancy schedule is used in conjunction with occupancy sensors. A typical Vassar space temperature setpoint reset schedule is as follows:

    a. Space Cooling Temperature Setpoints:

    Occupied: 75˚F ± 1.5˚F 0+
    Occupied Setback: 75˚F + 3.0˚F
    Unoccupied: 75˚F + 6.0˚F

    b. Space Heating Temperature Setpoints:

    Occupied: 70˚F ± 1.5˚F
    Occupied Setback: 70˚F – 3.0˚F
    Unoccupied: 70˚F – 6.0˚F

12. In addition to the temperature setpoint reset, during the occupied setback mode, the minimum airflow setpoint shall also be reset to 50% of the occupied flow setpoint.

B. Conference/Meeting/Auditorium/Classroom Zones

1. Control for meeting areas must be closely coordinated with the system design, but shall include temperature and ventilation control. Space control data shall be available on the BACS network.
2. Control shall include maintaining space temperature in the comfort range as defined by ASHRAE. Adequate ventilation shall be ensured by either occupancy sensing and indexing the ventilation to the ASHRAE 62 prescribed value upon occupancy, or by active control of CO2, modulating ventilation rates to maintain space CO2 below 900 PPM. Occupancy sensing shall generally be used for smaller facilities while active control will typically be used for larger facilities.

C. Office Zone Control

1. Control shall include maintaining space temperature in the comfort range as defined by ASHRAE. Generally, ventilation shall be provided by a dedicated ventilation system, with sufficient capacity and condition to offset the expected space latent gains.
2. Generally, using VAV with reheat is limited to modifications to existing systems.
3. For zones with passive radiant heating and cooling systems, the typical Vassar occupied, occupied setback, and unoccupied temperature setpoint reset schedule shall be modified. Our experience shows that the following reset schedule is sufficient to maintain proper comfort levels given the slower response speed of these types of systems:
    a. Space Cooling Temperature Setpoints:

    Occupied: 75˚F ± 1.5˚F
    Occupied Setback: N/A
    Unoccupied: 75˚F – 4.0˚F

b. Space Heating Temperature Setpoints:

Occupied: 68˚F ± 1.5˚F
Occupied Setback: N/A
Unoccupied: 68˚F – 4.0˚F

4. The following Standard Details reference typical office conditioning control strategies used at Vassar:

a. Detail 3.7.6 – Zone Control, Four Pipe Fan Coil Unit
b. Detail 3.7.7 – Zone Control, Radiant Heating and Cooling
c. Detail 3.7.8 – Zone Control, Baseboard Heating, Passive Chilled Beam Cooling
d. Detail 3.7.9 – Zone Control, Baseboard Heating, Active Chilled Beam Cooling
e. Detail 3.7.10 – Zone Control, VAV with Reheat

D. Computer Rooms and IT closets

1. Computer Rooms: Computer rooms will be controlled to temperature.
2. Space controllers shall be networked with the system-level or building-level controllers and other space controllers. Provide coordinated control to prevent energy waste from temperature control loop fighting.
3. Liquid sensors shall be provided below raised floors.

E. Loading Docks/Shipping And Receiving Areas

1. The BACS shall control the area to temperature as dictated by the system design. Space controllers shall be networked with the system-level or building-level controllers. The installation shall also include a CO sensor to alarm upon high levels of CO and initiate additional ventilation as permitted by the system design.

4.5 DUCT HEATING COILS

A. Provide manual over-ride and setpoint control capabilities for all sensors.

B. Provide separate heating setpoints for occupied and unoccupied schedules.

C. Status report: For each coil, the BMS shall provide an operating status summary of all unit sensed values setpoints and modes.

4.6 VAV ROOFTOP UNIT

A. If communication with the BAS is lost, the air handler controllers shall use their default setpoints and operate in the Occupied mode.

B. Occupied Mode:

1. When the rooftop unit is in the Occupied Mode, the Supply Fan shall operate continuously. The Supply Fan variable frequency drive shall modulate to maintain the Duct Static Pressure.

C. Unoccupied Mode:

1. When the rooftop unit is in the Unoccupied Mode, the Supply Fan shall be OFF. The Outside Air Damper shall be closed.

D. Night Setback Mode:

1. Supply fan to operate at minimum air flow, maintain set-back space temperature setpoint offs) or lowest associated zone T-stat.
2. Outside air damper to be at minimum.
3. Maintain a 6°F (adj.) offset to setpoint:
   a. Energize heat fully and energize fan at offset. Run until setpoint is reached, then de-energize fan and electric heat.
4. Operate terminal units in "Morning Warm-Up Mode", modulate variable frequency drive to maintain duct static pressure.

E. Morning Warm-Up Mode:

1. Supply fan shall run continuously and be energized one hour (adj.) prior to scheduled occupied mode start. Energize heating to warm-up occupied space to occupied setpoint of all associated space stats.
2. O.A. dampers shall be closed.
3. Cooling shall be locked out.
4. Energize heat fully until setpoint(s) are satisfied, maintain a 95°F (adj.) discharge air temperature.
5. Revert to occupied mode when all space stats have reached occupied heating setpoint.

F. Fan Safety Controls:

1. De-energize the Supply Fans whenever the Stop/Auto interlock is open, the Discharge Air Low Limit is tripped, the fire or smoke stat has tripped, or the Supply Fan Status indicates a failure (after a two minute delay). The Fire-stat, Low Limit and the Fan Failures require a manual reset.
2. Alarm the BMS with an appropriate alarm message.

G. Supply Fan Capacity Control:

1. When the Supply Fan is on, the variable frequency drive shall slowly ramp (adjustable) up to setpoint and modulate to maintain the proper Duct Static Pressure. The unit shall stop if the Static Pressure Sensors fail and alarm BMS. The Static Pressure Sensors shall be located by this Division.
2. Submit sensor locations to engineer for review.

H. Discharge Air Temperature:

1. Provide a "cascade" type reset (via a PID loop) of discharge air temperature (D.A.T.) to maintain space temperature.
2. Space humidity sensor shall override reset control and maintain humidity with highest possible D.A.T.
3. If D.A.T. drops below 40°F (adj.), de-energize all fans and close the outside air damper.

I. Electric Coil Control:

1. Electric coil shall stage on to maintain discharge air temperature.

J. Gas Heat Control:

1. Furnace shall modulate to maintain discharge air temperature.

K. Cooling Control:

1. The compressors shall modulate to maintain the Discharge Air Temperature at the Discharge Cooling Setpoint (55 F, adj.). The compressor shall be off if the rooftop unit is in the Heating mode, the Fans are OFF, or the Discharge Air Sensors have failed.

L. Relief Fan Control:

1. Relief fan variable frequency drive shall modulate to maintain building pressure of 0.05" (adj).

4.7 VARIABLE AIR VOLUME (VAV) TERMINAL UNITS

A. Refer to Air Terminal Unit specification for additional requirements.

B. Shut-Off VAV terminals:

1. On a rise in space temperature, the unit shall modulate to provide up to it's maximum CFM to maintain setpoint. As space temperature decreases, the unit shall modulate down to it's minimum cooling CFM to maintain setpoint.
2. Each VAV box shall have a ventilation setpoint input. This setpoint shall be used along with the ASHRAE Std. 62-1989, Equation 6-1 to reset the corresponding Air Handler Outside Airflow (CFM) to maintain proper ventilation for each VAV zone. See VAV air handler sequences for interface of VAV ventilation into the building automation system.

C. Constant Volume Terminal Units

1. When the associated air handler/fan coil is operating the constant volume valve shall maintain its preset amount of outside air to the air handler/fan coil.
2. When the associated air handler/fan coil is off the constant volume valve shall close.

D. Shut-Off VAV Terminals with Heat:

1. On a rise in space temperature above the cooling setpoint, the unit shall modulate up to it's maximum CFM to maintain setpoint. As space temperature decreases, the unit shall modulate down to its minimum cooling CFM to maintain setpoint.

   As the space temperature continues to fall below the cooling temperature setpoint, the unit shall modulate to its fixed cooling minimum CFM. At the same time, the heating coil shall maintain cooling setpoint.
2. Each VAV box shall have a ventilation setpoint input. This setpoint shall be used along with the ASHRAE Std. 62-1989, Equation 6-1 to reset the corresponding Air Handler Outside Airflow (CFM) to maintain proper ventilation for each VAV zone. See VAV air handler sequences for interface of VAV ventilation into the building automation system.

E. Series Fan Powered Boxes:

1. Occupied Mode:
   a. Fan runs continuously.
   b. On a rise in space temperature the primary valve shall modulate up to its maximum CFM to maintain setpoint. As space temperature decreases the primary valve shall modulate to minimum and the electric coil shall maintain setpoint.
2. Unoccupied Mode:
   a. The primary valve shall be at minimum. Modulate the electric coil and fan to maintain the unoccupied setpoint.

F. Parallel Fan Powered Boxes:

1. Occupied Mode:
   a. Cooling
      1) Fan shall be off and heat de-energized.

2) On a rise in space temperature above cooling setpoint the unit shall modulate up to its maximum cfm to maintain setpoint as space temperature decreases the unit shall modulate to its minimum cooling setpoint.

b. Heating
1) The primary valve shall modulate to minimum position. The fan shall energize and heating coil shall modulate to maintain setpoint.

2. Unoccupied Mode:
a. Fan and heating coil shall cycle to maintain space temperature.

G. Morning Warm-Up:

1. When the respective air handler for a VAV box operates in the morning warm-up mode, the VAV box shall operate as a "heating air valve".
2. Maintain full cfm cooling airflow until the zone sensor is satisfied (space temperature rises). As space setpoint is reached, modulate air valve fully closed until AHU unit reverts to "OCCUPIED" operating mode.
3. Heating control valve shall be fully open.

H. Alarm the time, VAV box designation and duration of all VAV over-rides.

4.8 KITCHEN MAKE-UP AIR UNIT

A. Whenever the kitchen hood is energize, the make-up air unit fan motor is energized the outdoor air damper shall open, the interlocked kitchen exhaust fan shall start and the control system shall be activated. Whenever the kitchen hood is disabled, the kitchen exhaust fan is off, make-up air unit fan motor is off the outdoor air damper shall be closed and the face damper open. The BMS shall index the system between summer and winter.

B. Winter:

1. During "winter" the face and bypass dampers and the heating coil valve, shall modulate in sequence, to maintain a fan discharge temperature of 55˚F (adj.). With a rise in temperature, the face damper shall gradually close and the bypass damper shall gradually open. With a continuous temperature rise, the heating coil valve shall gradually close. A low limit temperature sensor may overcall the fan discharge temperature sensor to maintain a heating coil discharge temperature of 45˚F (adj.).

C. Summer:

1. The summer-winter switch shall be indexed to "summer" the heating coil shall be disabled, the face damper shall open and the bypass damper shall close.

4.9 PRESSURE BYPASS CONTROL

A. A differential pressure controller, sensing supply water and return water pressures for its system, shall modulate a bypass valve to maintain its setting. Valve shall be normally closed for hot water and normally open for chilled water.

4.10 CABINET HEATERS (ROOM CONTROL)

A. For each unit, a room temperature sensor set at 70˚F (adj.) shall control, in sequence, the heater fan and the heating coil valve, to maintain its setting. With a drop in temperature first the fan shall start, and next the temperature sensor shall modulate the heating coil valve open.

4.11 CABINET HEATER (RETURN AIR CONTROL)

A. A return air temperature sensor, accessible through the removable unit access panel or return grille, shall modulate a hot water control valve to maintain its setting.

4.12 EXHAUST FAN CONTROL

A. When the exhaust fan is started, a normally closed damper in the fan outlet shall open. When the fan is stopped, the damper shall close.

B. For dampers furnished by the fan manufacturer, fan manufacturer shall provide electric, totally enclosed, spring return damper motors and dampers, and control manufacturer shall wire to load side of local disconnect switch.

C. For Elevator Equipment Room, provide a room temperature sensor, set at 80˚F., to cycle its respective exhaust fan motor, on a rise in temperature. When the fan starts, its outside air intake damper shall open. For two speed motors, fan shall operate at low speed below 80˚F. and at high speed above 80˚F.

4.13 DIRECT RADIATION

A. Provide room temperature sensor where shown on Drawings, to control a hot water control valve on the water supply line to each radiation element, to maintain 72˚F.

B. In rooms with direct radiation control and reheat control, a single room temperature sensor shall control the radiation and reheat coil, in sequence, on a rise in temperature.

C. Provide self-contained control valves where shown on Drawings to maintain 72˚F.

4.14 SOLAR THERMAL SYSTEM

A. Manufacturers: Resol

B. Contractor shall provide all necessary controls and communication interfaces to control the solar thermal system (pumps, panels, etc.) and connect the solar thermal system to the building BMS system to track system status and performance. System shall be BACnet compatible.

C. Contractor shall provide all temperature probes, pressure sensors, control valves, alarm modules, flow meters, extension modules, sensors, Dataloggers (DL3), smart display (SD3) and all control interfaces required for a fully function and integrated system.

D. All hot water generation shall be trended within the BMS.

4.15 EMERGENCY GENERATOR

A. When the emergency generator starts, its bypass damper shall open, and the control system shall be energized. Outside air and spill air damper shall remain closed.

B. A room temperature sensor shall modulate the bypass, spill and outside air dampers to maintain its setting of 85˚F. As the space temperature rise, the bypass damper shall gradually close and the outside air damper and discharge air damper shall gradually open, in tandem. With a decrease in temperature, the reverse shall occur.

C. When the generator stops, all the dampers shall close.

D. Outside air and spill air dampers shall fail open on a loss of air pressure.

4.16 CONTROL OF SMOKE DAMPERS

A. Provide a normally closed automatic damper in each duct crossing a smoke barrier, as indicated on the Drawings, at the point where the duct crosses the barriers and at supply fan discharge. Whenever supply fan stops, smoke damper at the fan discharge shall close. Provide one minute time delay to prevent fan start-up until smoke damper has opened and 20 second time delay to prevent damper from closing until fan stopped. All smoke dampers on each floor, shall be connected to E-p switches on that floor, which shall close the dampers when deenergized by the smoke detection system provided under Division 16. E-p switches shall be 1/4", 3-way air valve, connected to the damper air piping system. Provide one-minute time delay to prevent fan start-up until its respective smoke dampers have opened, and 20-second time delay to prevent dampers from closing until fan has stopped. E-p switch shall be furnished under this Section of the specifications.

4.17 VARIABLE FREQUENCY DRIVES

A. The BACS shall provide for seamless integration with the control of the VFDs and associated systems. The interface shall be hardwired (point-by-point wiring to applicable terminations on the drives interface board) for start/stop, status and speed signals. The status shall be determined via contacts from the drive. The drive specification must be coordinated to ensure that the status contacts are available and are a true feedback indication that the motor is running. The speed signal shall be 0-10VDC. Digital communications via a controller LAN shall be used to gather all other available diagnostic information.

4.18 MOTOR STARTERS

A. An HOA switch shall be provided with the starter. In the hand position the motor shall start and run continuously unless a safety device trips; in the off position the motor shall stop; in the auto position the BACS shall control the motor per described sequences of operation.

B. Status shall be monitored by the BACS, preferably with a current sensor. Motor status shall be monitored via an adjustable de-bounce time. The BACS shall annunciate a “failure” alarm whenever the motor is commanded to run and status is not proved within an adjustable de-bounce time. In the failure mode, the run command shall remain, except on headered systems for which the run command will be removed requiring manual acknowledgement. In no case shall a loss of status coincident with a loss in power be alarmed as a failure. The BACS shall include controller arrangement and/or points or programming as required to accomplish the above.

4.19 DDC SYSTEM POINTS LIST

A. General: Provide individual inputs or output for each point listed in the points list (See Appendix). Provide any additional points not listed in the points list, but required to meet the sequences of operation, at no additional cost to the owner. All analog outputs shall be 4-20mA, 0-10VDC, or 0-20VDC unless otherwise indicated.

B. Points types include the following:

1. Binary Input (BI)/Digital Input (DI): An on/off indication that has a maximum cycle rate of 1 Hz. This is typically sensing a contact closure.

2. Binary Output (BO)?Digital Output (DO): A contact closure on the controller that will cause an action in the system.

3. Binary Value (BV)/Digital Value (DV): A network-visible binary point whose value is determined by a controller computation.

4. Analog Input (AI): A continuously varying voltage or amperage signal that is varied by a sensor in relation to a sensed variable. This signal is processed in the controller after an analog-to-digital converter on the controller that converts the analog signal to a digital value.

5. Analog Output (AO): A continuously varying voltage or amperage signal that is generated from the controller after digital-to-analog conversion. The voltage or amperage signal will be used, for instance, to drive a modulating actuator or reset a hardwired setpoint on a packaged device.

6. Analog Value (AV): A network-visible analog point whose value is determined by a controller computation.

7. Pulse-Width-Modulated Output (PWM): A time-based algorithm converts a standard BO into a modulating signal. Based on the duration of the pulse, the recipient of the signal positions the device proportional to the duration of the pulse.

8. Pulsed Input (PI): A binary input with increased cycle rate capabilities, capable of directly counting and buffering pulses that may emanate from a metering device.

4.20 MISCELLANEOUS DDC CONTROL

A. See the points list for additional required alarm and status points which shall be monitored by the BMS.

B. Reference mechanical equipment schedules (especially "fans") for additional control sequences.

4.21 MISCELLANEOUS NON-DDC CONTROL

A. Chemical Treatment: Provide required field wiring interlocks.

B. Unit Heater: Cycle the unit fan from a line voltage temperature sensor to maintain temperature setpoint.

END OF SECTION

SECTION 23 09 01

BUILDING AUTOMATION AND CONTROL SYSTEM COMMUNICATIONS AND INTEROPERABILITY

PART 1 - GENERAL

1.1 GENERAL

Historically, the use of building automation and direct digital control systems has been hampered by the difficulties associated with interconnecting systems from different manufacturers to one another and to the campus Energy Management and Control System (EMCS). A result has been the development of ANSI/ASHRAE Standard 135-2004, BACnet - A Data Communication Protocol for Building Automation and Control Networks. BACnet is now, also, an international standard, ISO 16484-5.

1.2 OVERVIEW

This section provides the communication and interoperability requirements for building automation and control system components to be supplied. Because the systems have evolved over many years and involve products from multiple vendors and, in several cases, multiple generations of control systems from single vendors, attention must be given to the integration of the old and the new. The objectives of this integration include: providing a mechanism for competitive procurement of building control products; assisting in meeting the environmental protection goals; improving the operational systems available to our facilities management and operations staff; reducing, if possible, overall facilities management costs; and providing an infrastructure for optimizing performance in a deregulated utility environment.

The objectives shall be met by the use, to the extent possible, of existing, widely- accepted data communication standards and practices.

1.3 APPLICABLE STANDARDS

The following standards shall govern the design and selection of equipment supplied to fulfill the requirements of this section:

A. ANSI/ASHRAE Standard 135-2004: BACnet® - A Data Communication Protocol for Building Automation and Control Networks, as amended, and hereinafter referred to as “BACnet,” American Society of Heating, Refrigerating and Air- Conditioning Engineers, Inc. 2004.

B. ATA/ANSI 878.1 (1992), ARCNET Local Area Network.

C. ISO/IEC 8802-3 (1993), Information processing systems - Local area networks - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

1.4 DEFINITIONS

In addition to the definitions contained in the applicable standards of 1.03, the following should be noted:

A. ARCNET - Attached Resource Computer Network. See BACnet, Clause 8 and ATA/ANSI 878.1.

B. BACnet/IP - BACnet Annex J Devices. Annex J of BACnet describes how BACnet devices can make use of IP directly for communicating across IP-based internets.

C. BACnet PICS - A Protocol Implementation Conformance Statement that describes the BACnet capabilities of a specific device. See BACnet, Annex A.

D. BACS - Building Automation and Control System.

E. BBMD - BACnet Broadcast Management Device. See BACnet, Annex J.

F. BMA - BACnet Manufacturers Association.

G. BTL - The BACnet Testing Laboratories of the BMA. The organization responsible for testing products to assure that they conform to the BACnet standard. Listings of tested products are available at www.bacnetassociation.org.

H. Campus Backbone - A fiber optic data communication infrastructure on the campus. Users connect to the backbone by means of Ethernet concentrators in each building and appropriate 10/100BASE-T unshielded, twisted pair wiring. The backbone uses the Internet Protocol (IP) for routing messages to and from computers both on and off the Vassar campus.

I. CIS - Vassar Information Technologies. The organization that manages the Vassar campus networking infrastructure, including the provision of network connections in Vassar buildings.

J. Computer Section - The computer group within the Vassar Utilities and Energy Management Department. The Computer Section is responsible for the EMCS and the coordination of BACS device addressing and network numbering.

K. BIBB - BACnet Interoperability Building Block. A collection of one or more BACnet services defined for the purpose of describing communication functionality in an unambiguous way. See BACnet, Annex K.

L. Device Profile - A collection of BIBBs that describes the minimum BACnet capabilities of a particular device in order to achieve reliable communication in one of five specified “interoperability areas.” Devices include BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC) and BACnet Application Specific Controllers (B-ASC). See BACnet, Annex L.

M. EMCS - A computer complex, housed at Chilled Water Plant 1 that provides Energy Management and Control System functions for the College. The EMCS is connected to the campus backbone and uses the IP for the routing of messages to and from individual buildings.

N. Ethernet - A carrier sensing multiple access with collision detection network technology defined by ISO/IEC 8802-3.

O. Gateway - A device that translates BACnet messages into those of a non-BACnet protocol and vice-versa.

P. Internetwork - A set of two or more BACnet networks interconnected by routers.

Q. Interoperability Area - A communications domain in which functional cooperation is desired. These areas are currently: 1) data sharing; 2) alarm and event management; 3) trending; 4) scheduling; and 5) device and network management. See BACnet, Clause 22.

R. IP - The Internet Protocol. A networking protocol originally developed by the federal Defense Advanced Research Projects Agency. BACnet messages can traverse the campus backbone by being encapsulated in routable IP packets.

S. Local - Pertaining to the requirements of a specific job or building project.

T. LAN - Local Area Network. One of the approved BACnet network technologies: Ethernet, ARCNET or MS/TP.

U. MS/TP - Master-Slave/Token-Passing Network. One of the approved BACnet LANs. See BACnet, Clause

9.

V. Network - One of the communication technologies for data communications specified in BACnet. Approved network technologies at Vassar are Ethernet, ARCNET and MS/TP.

W. PICS - Protocol Implementation Conformance Statement. A document that describes in detail a device's BACnet capabilities. See BACnet, Annex A.

X. UDP - The User Datagram Protocol. One of the IP family of protocols. UDP is used to convey BACnet/IP messages and is characterized by a "port number" for each protocol. BACnet/IP typically uses UDP port X'BAC0' or decimal 47808.

Y. VLAN - Virtual Local Area Network. A network configuration that allows devices to communicate across multiple physical local area networks (LANs) using their hardware or "medium access control" (MAC) addresses as if they shared a common networking medium. As with a physical LAN, "local" broadcast messages are also propagated to each of the participating LANs. VLAN capability depends on the configuration of the interconnecting data communication equipment. VLAN configuration is performed by CIT.

1.5 SUBMITTALS

In addition to any requirements specified elsewhere, the Contractor shall provide both proposed and as-built versions of the following:

A. Schematic drawings that represent the system architecture and configuration, in both hardcopy and editable electronic format.

B. A points list that includes, for each physical or logical point, the name, description, display units, alarm limits and definitions, along with the BACnet object description, object ID, and associated device ID. The list shall also indicate whether Trend Log or Schedule objects have been established for the point.

C. Documentation for any non-standard BACnet objects, properties, or enumerations utilized detailing their structure, data types, and any associated lists of enumerated values.

D. PICS files indicating the BACnet functionality and configuration of each device. In addition to the requirements of BACnet, Annex A, the Contractor shall provide information on any limitations on the numbers of supported objects in a given device including, specifically, Trend Log and Schedule objects.

E. Documentation on submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL) or a letter on manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment shall be provided to upgrade installed controls to a version that meets BTL testing and listing requirements should deficiencies be found during BTL testing.

1.6 COORDINATION

The Contractor shall be responsible for all coordination of subcontractors' work relative to the BACS. Specific questions relating to communication and interoperability shall be submitted to the Computer Section.

PART 2 - PRODUCTS

2.1 GENERAL

Each networked device supplied pursuant to this section shall be installed and configured so as to correctly execute all sequences of operation for its intended application, as defined in other sections of this specification. In addition, each networked device shall provide, at a minimum, the BACnet communication capabilities prescribed in the device profiles for devices of its type. See 2.02.

2.2 REQUIREMENTS FOR SYSTEM COMPONENTS

This clause prescribes the minimum requirements for devices supplied pursuant to this section.

A. Controller Requirements: Controller devices supplied to meet the functional and operational requirements of this specification shall conform, at a minimum, to one the BACnet device profiles contained in BACnet, Annex L: BACnet Building Controller (B-BC), BACnet Advanced Application Controller (B-AAC) or BACnet Application Specific Controller (B-ASC). The interoperability requirements of such devices are contained in BACnet, Annex L. B-BC controller devices shall communicate using BACnet/IP. Other devices may use BACnet over ARCNET or BACnet over MS/TP.

B. Router Requirements: In the event that devices are provided that do not use BACnet/IP over Ethernet as their communication technology, BACnet routers shall be provided that route between BACnet/IP over Ethernet and the other BACnet LAN type(s), whether ARCNET or MS/TP. These routers shall conform to the specifications of BACnet, Clause 6.

C. Gateways: BACS devices that use BACnet as their native protocol are preferred. The use of gateways, in circumstances where no native BACnet devices are available, requires the specific approval of the Owner in each instance.

D. Workstation Requirements: The EMCS operator interface is the responsibility of the Computer Section. If, however, a specific job requires a local workstation, the Contractor shall provide a personal computer of current design and approved by the Owner equipped with a Web browser that can display information from a Contractor-supplied Web server that interfaces with the local BACnet network and the campus backbone, as described 2.02.E.

E. Web Server Requirements: If a local workstation is required, the Contractor shall comply with 2.02.D and shall, in addition, provide a Web server computer with the Web page presentation, data acquisition and storage functionality described in this section, including the specific functions listed below. The Web server shall be configured in such a way that there is no software-imposed limit to the number of simultaneous users.

1. Data Sharing:
   - Presentation of data (i.e., user definable reports and graphics)
   - The ability to monitor and display the values of all BACnet object types, including all required and optional properties.
   - The ability to modify setpoints and parameters.

2. Alarm and Event Management:
   - Operator notification and presentation of event information
   - Alarm acknowledgment by operators
   - Alarm summarization
   - Adjustment of alarm limits
   - Adjustment of alarm routing

3. Scheduling:
   - Modification of schedules

- Display of the start and stop times (schedule) of scheduled devices.

4. Trending:
   - Modification of the parameters of a trend log
   - Display and archive of trend log data

5. Device and Network Management:
   - Display of information about the status of any device on the BACnet internetwork.
   - Display of information about any object on the BACnet internetwork.
   - Ability to silence a device on the network that is transmitting erroneous data.
   - Ability to cause a remote device to reinitialize itself.
   - Ability to backup and restore the configuration of devices on the local BACnet network.
   - Ability to query and change the configuration of local BACnet routers.

2.3 REQUIREMENTS FOR NETWORK CONNECTIONS

This clause prescribes the means of interconnecting BACS devices provided pursuant to this specification.

A. Local Area Networks (LANs)

1. All control devices meeting the B-BC device profile shall be connected to an ISO 8802-3 (Ethernet) LAN provided by the Contractor. This LAN, in turn, shall be connected to the campus backbone network. Unless otherwise specified, the connection shall be via a 10/100BASE-T port provided by the Owner. The Contractor shall also provide any additional data communication hardware, such as hubs and repeaters, which may be needed to interconnect the supplied BACS equipment and to connect to the Owner's backbone network.
2. To facilitate maintenance technician access to the LAN, the Contractor shall also provide at least one additional 10/100BASE-T access point in each mechanical room that contains BACS equipment. This requirement may be met by supplying either a hub with a spare port or a dedicated jack.
3. Control devices that meet the B-ASC profile, but do not support Ethernet, must use another approved BACnet LAN technology. These technologies are ARCNET and MS/TP. If Ethernet is not supported on any part of the internet- work, a standalone BACnet router, or a BACnet Building Controller with built- in routing capability, must be provided for routing between the Ethernet and ARCNET or MS/TP LANs.

PART 3 - EXECUTION

3.1 GENERAL

This clause provides specific interoperability and networking requirements that pertain to the use of BACnet.

3.2 REQUIREMENTS BY INTEROPERABILITY AREA

This clause provides requirements pertaining to the five interoperability areas of data sharing, alarm and event management, trending, scheduling, and device and network management.

A. Data Sharing: Data Sharing requirements apply to the exchange of information between BACnet devices for archival storage, generating graphics and reports, the sharing of common sensor or calculated values, carrying out interlocked control strategies, and the modification of setpoints or other operational parameters.

All such data to be exchanged shall be represented as BACnet objects and conveyed using BACnet messages. Only standard BACnet objects and messages may be used to implement data sharing requirements unless the non-standard extensions are explicitly approved by the Owner. Any extensions to BACnet shall be fully documented in the manner used within the BACnet standard. Submission of such documentation is a prerequisite for obtaining approval of an extension.

1. Points List:

   The Contractor shall provide devices installed and configured with all points indicated in the BACS points list. The Contractor shall provide any additional points needed to fully implement the sequence of operations and other functionality described in this specification.

2. Data Presentation:

   In the event that workstation/web server capabilities have been specified, the following characteristics shall apply to graphic displays:

   a. The graphic displays shall include schematic diagrams of the systems being displayed.
   b. When a graphic display is being viewed all values displayed shall be updated when a change of value (COV) notification is received or, if COV is not implemented, within five seconds.
   c. Any data value from any networked device shall be available for plotting at a workstation in real time. The operator shall be able to select binary and analog data concurrently and to plot multiple instances of each data type on the same screen. The operator shall be able to select sampling intervals from 1 second to 60 seconds. For devices that implement COV reporting, the operator shall be able to select this as the means to update the plot. It shall be possible to save such real-time plots for subsequent recall.

3. Monitoring of Any Property:

   The operator shall be able to display any value of any property of any object from any networked device including all properties required by BACnet, all supported optional properties, and any proprietary extensions.

4. Global Object Definitions:

   The control system shall be configured with system-wide unique BACnet objects as needed to convey all globally significant information necessary to implement the control strategy.

5. Setpoint and Parameter Modifications:

   Operators with appropriate authority shall be able to modify all control loop setpoints and tuning parameters via BACnet messages initiated through operator interaction with graphics displays.

6. Peer-to-Peer Data Dependencies:

   All BACnet devices shall be installed and configured to exchange data values directly, without the need for operator or workstation intervention, to implement the sequence of operations specified in the mechanical system drawings and to share global data values.

B. Alarm and Event Management

1. Alarm and Event Management is the exchange of data between BACnet devices related to the

occurrence of predefined conditions that meet specific criteria. Such conditions are called “events” and may be the basis for the initiation of a particular control action in response or the simple logging of the event’s occurrence. The event may also be deemed to represent a condition that constitutes an “alarm” requiring human acknowledgment and intervention.

2. All alarms and events shall be implemented using standard BACnet event detection and notification mechanisms. Either intrinsic reporting or algorithmic change reporting may be used but the intrinsic reporting method is preferred. See BACnet, Clause 13.
3. Alarm Lists:

    a. The Contractor shall provide devices installed and configured to detect alarms and events for the points indicated in the system drawings. Software logic shall be provided to avoid nuisance alarms, e.g., no temperature or status alarms shall be generated when fan systems are not running or during start-up and shut-down transitions. It shall be possible to configure a delay between the occurrence of an alarm condition and its enunciation.
    b. Alarms shall appear at the EMCS and any local operator workstation(s) within five seconds of their occurrence. The workstations shall display an alarm message window that appears on top of any other open windows. The alarm message window shall have a distinctive color and appearance to attract the operator's attention. Operators with sufficient privilege shall be able to configure the workstation to emit an audible signal (or not) when an alarm message is received.
    c. Alarms that require operator acknowledgement shall cause the alarm window to remain active until such an acknowledgement is received. If multiple alarms are received, unacknowledged alarms shall be displayed on a first come first served basis grouped by priority, with the highest priority alarms displayed first.
    d. Alarms shall be distributed using the BACnet notification class mechanism. Assignment of classes and destinations shall be configured according to details provided by the Owner. One destination shall, in all cases, be the EMCS.
    e. BACnet provides a mechanism for prioritizing alarm and event notification messages using a numerical range of 0-255 with 0 being the highest priority and 255 being the lowest priority. The priorities presented in the Table 1 are consistent with the safety requirements of UL 864 (applies to fire systems) and UL 1076 (applies to security systems).
    f. Alarm and event notification priorities shall be configured in the Priority Range as indicated in Table 1 below, and shall be conveyed using the indicated Network Priority. See BACnet, Clause 6.

Table 1. Alarm and Event Priorities

Message Group	Priority Range	Network Priority	Brief Description
Life Safety	00 - 31	Life Safety Message	Notifications related to an immediate threat to life, safety or health such as fire detection or armed robbery.
Property Safety	32 - 63	Life Safety Message	Notifications related as an immediate threat to property such as forced entry.
Supervisory	64 - 95	Critical Equipment Message	Notifications related to improper operation, monitoring failure (particularly of Life Safety or Property Safety monitoring), or monetary loss.
Trouble	96 - 127	Critical Equipment Message	Notifications related to communication failure (particularly of Life Safety or Property Safety equipment).
Miscellaneous Higher Priority Alarm and Events	128 - 191	Urgent Message	Higher-level notifications related to occupant discomfort, normal operation, normal monitoring, or return to normal.
Miscellaneous Lower Priority Alarm and Events	192 - 255	Normal Message	Lower-level notification related to occupant discomfort, normal operation, normal monitoring, or return to normal.

4. Alarm Acknowledgment:

   Alarms shall be acknowledged through the EMCS alarm acknowledgement process.

5. Alarm Summarization:

   Alarm summarization shall be handled through the EMCS alarm summarization process.

6. Alarm Parameter Adjustment:

   Operators with sufficient privilege shall be able to change alarm parameters for all standard BACnet event types.

7. Alarm Routing Adjustment:

   Operators with sufficient privilege shall be able to change alarm routing (BACnet notification classes) for each alarm including the destination for each type of alarm and alarm priority, the day of week and time of day, and the type of transition involved (TO-OFFNORMAL, TO-NORMAL, etc.).

   Initially, notification classes shall be configured in a manner that distinguishes between the EMCS and any local workstation, if provided.

C. Scheduling

Scheduling is the exchange of data between BACnet devices related to the establishment and maintenance of dates and time at which specified output actions are to be taken. All schedules shall be implemented using BACnet objects and messages.

1. Schedule Lists:

   a. The Contractor shall provide devices installed and configured with start/stop, mode change, and night setback schedules as defined in the sequence of operations. As part of the installation process, the Contractor shall configure vacation, holiday, and any special event schedules as provided by the Owner.
   b. The system shall have the ability to program alterations to programmed operating schedules based on the priority of events and shall include the following scenario:

      - Based on operator privileges, the operator shall have the ability to temporarily override the programmed schedule of equipment. Operational override of a programmed schedule shall be for a specific duration following which the schedule shall revert back to the preprogrammed schedule.

2. Display of Start and Stop Times and Actions:

   An operator shall be able to inspect the content of any schedule and determine the specific control actions that will occur at any time, on any date. For any particular device or system parameter that is the subject of a schedule, an operator shall be able to determine the schedule of actions related to that particular device or parameter.

3. Modification of Schedules:

   All calendar entries and schedules shall be modifiable from the EMCS or local workstation by an operator with sufficient privilege.

D. Trending

Trending is the accumulation of (time, value) data pairs at specified rates for a specified duration. Trends are distinguished from real-time plotting of data by the fact that the data are destined for long-term storage.

1. Archival Storage of Data:

Archival storage of data will be handled by the EMCS. However, the Owner may specify local trend archiving and display through the use of BACnet Trend Log objects.

2. Modification of Trend Log Parameters:

An operator with sufficient privilege shall be able to change the data points to be logged, the sampling rate, and the duration of a trend log.

E. Device and Network Management

Device and network management is the exchange of data between BACnet devices concerning the operation and status of specific devices. If local workstation capabilities are provided, the following functions shall be available:

1. Display of Device Status Information:

Operators shall be able to display at any time the operational status of any device on the BACnet internetwork.

2. Display of BACnet Object Information:

Operators shall be able to display, at any time, any property of any BACnet object. Operators shall be able to display property values of objects grouped by object type, object location, and building system.

3. Silencing Devices that are Transmitting Erroneous Data:

Operators shall be able to direct a field device to stop transmitting event, alarm or COV notifications until a subsequent command to resume transmissions is received.

4. Time Synchronization:

Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, or all devices on a single local network.

5. Remote Device Reinitialization:

Operators shall have the ability to issue reinitialization commands to any device that supports remote reinitialization.

6. Backup and Restore:

Operators shall have the ability to backup and restore all BACnet devices on the network that

support this capability.

7. Configuration Management of Half-Routers, Routers and BBMDs:

Operators shall have the ability to display and modify the routing table entries in all supplied BACnet half-routers and routers and the broadcast distribution and foreign device registration tables in all BBMDs.

3.3 USE OF BACNET OBJECTS

This clause provides requirements that are specific to the representation of data and functionality using BACnet objects.

A. Naming Conventions: The following sections list the requirements for the assignment of names and identifiers for BACnet objects:

1. Device Names:

The EMCS uses a system for naming its control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. Names can be up to 254 characters in length, without embedded spaces. Only the characters A-Z, 0-9, ".", and "-" may be used. The goal is the shortest descriptive, but unambiguous, name. For example, if there is only one chilled water pump "P1", a valid name would be "DUFFIELD.CW.P1.CONTROL".

If there are two pumps designated "P1", one in the basement mechanical room and one in the penthouse mechanical room, the names could be "CHP.BSMT.CW.P1.CONTROL" or "CHP.PENT.CW.P1.CONTROL". In thecase of unitary controllers, for example a VAV box controller, a name might be "COURT.122.TV-LOUNGE". These names should be used for the value of the "Object_Name" property of the BACnet Device objects of the controllers involved so that the BACnet name and the EMCS name are the same.

2. Device Instance Numbers:

a. BACnet allows 4194305 device instances per BACnet internetwork, each of which must be unique. Vassar's unique device instances are formed as follows: Device Instance = "FFFFNDD" where:

FFFF	=	Facility Code (see below)
N	=	0-9 This allows up to 10 networks per facility or building.
DD	=	00-99 This allows up to 100 devices per network.

b. Facility Code assignments are currently:

0000-0999	Open
1000-1999	Statutory Facilities
2000-2999	Endowed Facilities
3000-3999	Housing and Dining Facilities 4000-
4999	Off-Campus Facilities
5000-5999	Utilities

c. Some facilities have a facility code with an alphabetic suffix to denote wings, related

structures, etc. The suffix will be ignored. Network numbers for facility codes above 4193 will be assigned in the range 0000- 0999.

d. The Contractor shall contact the Computer Section for assignment, or confirmation, of the Facility Code to be used prior to beginning device configuration.

3. Non-Device Object Names:

Objects other than Device objects shall be named in a manner analogous to Device objects. The names shall consist of a facility.[sub-facility.]system.[sub- system.]point designation.

4. Non-Device Object Instance Numbers:

The instance numbers for objects other than Device objects may be assigned at the Contractor's discretion subject only to the constraint that they be unique for a given object type within a given device.

B. Commissioning/Diagnostic Mode

In order to support commissioning and troubleshooting functions, the Out_Of_Service property of all Analog, Binary, Multi-state, Loop, and Program objects shall be writable using BACnet services.

C. Using Object Descriptions

1. Each device object and every object in BACnet Building Controllers (B-BC) shall be configured with a Description property. The descriptions used shall be submitted to the Owner for approval.

2. For all object types in all devices that support Description properties, the available string length and whether or not the Description is writable using BACnet services shall be specified in the device's PICS.

D. Issues Relating to Specific BACnet Object Types

This clause provides requirements that pertain to the use of specific BACnet object types.

1. Analog Input, Output, and Value:

All Analog_Input, Analog_Output, and Analog_Value objects shall have the capability of using the change of value (COV) reporting mechanism and the COV_Increment property shall be writable using BACnet services.

2. Binary Input:

The Inactive_Text and Active_Text properties of Binary Input objects shall be configured with text string values as indicated on the points list. Binary Input objects shall support COV reporting.

3. Binary Output:

The Inactive_Text and Active_Text properties of Binary Output objects shall be configured with text string values as indicated on the points list. All Binary Output objects associated with motor on/off status shall track changes of state and runtime. Binary Output objects shall support COV reporting.

4. Binary Value:

   The Inactive_Text and Active_Text properties of Binary Value objects shall be configured with text string values as indicated on the points list. Binary Value objects shall support COV reporting.

5. Calendar:

   1. Devices providing scheduling capability shall also provide at least one Calendar object with a capacity of at least ten entries. Operators shall be able to view the calendar object and make modifications from any BACnet workstation on the network.

   2. If the Calendar's Date_List property is writable using BACnet services, all calendar entry data types shall be supported.

6. Loop:

   All control loops using any combination of proportional, integral, and/or derivative control shall be represented by BACnet Loop objects. Operators with sufficient authority shall be able to adjust at least the Update_Interval, Setpoint, Proportional_Constant, Integral_Constant, and Derivative_Constant using BACnet services. Loop objects shall support COV reporting.

7. Multi-state Input, Output, and Value:

   The text to be used for the Multi-state object types shall be determined from the points list. Feedback_Value shall be determined by sensing the actual condition or mode of the device. All Multi-state objects shall support COV reporting.

8. Schedule:

   All building systems with date and time scheduling requirements shall have schedules represented by BACnet Schedule objects. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any BACnet workstation. Required schedules are shown on the drawings as part of the occupied and unoccupied modes.

E. Dynamic Object Creation

   BACnet Building Controllers shall be configured to allow the dynamic creation of Trend Log, Calendar, and Schedule objects by means of the BACnet CreateObject service. This shall be possible from any supplied BACnet workstation by operators with appropriate authority.

3.4 USE OF BACNET SERVICES

This clause provides requirements that are specific to the use of BACnet communication services.

A. Interoperable Commands

   All dampers, valves, fans, or other mechanical equipment that may need to be controlled by more than one application shall be represented as commandable BACnet objects. The application programs interacting with this equipment shall be configured to use the command priorities listed in Table 2. If implementing the sequence of operations or other required functionality requires using a command priority not listed in Table 2, the priority assignment must be approved by the Owner.

Table 2. Command Priorities

Priority Level	Application	Priority Level	Application
1	Manual-Life Safety	9	Available
2	Automatic-Life Safety	10	Available
3	Available	11	Load Shedding
4	Available	12	Available
5	Critical Equipment Control	13	Available
6	Minimum On/Off	14	Available
7	Available	15	Available
8	Manual Operator	16	Available

B. Alarming

This clause provides requirements that are specific to the use of BACnet for alarm processing.

1. Alarm Priorities:

All alarm and event notification priorities shall be configured as indicated in 3.02.B.1.

2. Notification Classes:

The EMCS shall be designated as a recipient for all alarm notifications.

The Priority, Ack_Required, and Recipient_List properties of Notification Class objects shall be writable over the network using BACnet services.

3. Event Notification Message Texts:

Alarm and event processing shall be configured to convey descriptive text messages along with the notification.

C. Operator Authority Levels

If local workstation capability is provided, there shall be at least three levels of authority:

Administrator - All privileges
Control Shop - All programming and configuration Building Coordinator -
Read only

D. Change of Value Processing

1. All local workstations shall be able to display property values based on the receipt of confirmed and unconfirmed Change of Value notifications. Operators shall have the ability from any workstation to subscribe to COV notifications for all objects that support COV subscriptions.

2. After initialization, all graphic display screens shall update the displayed values using COV notifications if COV notification capabilities are available from the data source.

3. The COV increment shall be adjustable by an operator using BACnet services.

3.5 LOCAL AREA NETWORKS

This clause provides requirements that are specific to the integration of multiple BACnet networks, possibly on different LAN types, into a single BACnet internetwork.

A. Network Numbering

1. Vassar BACnet network numbers are based on a "facility code, network" concept. The "facility code" is the Vassar-assigned numeric value assigned to a specific facility or building. See 3.03.A.2 above. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internetwork.

2. Vassar's network numbers are thus formed as follows: Network Number = "FFFFN" where:
FFFF = Facility Code
N = 0-9 This allows up to 10 networks per facility or building.
N = 0 will generally be assigned to a facility's BACnet Ethernet LAN. Normally, this network is connected to the campus backbone. The additional N-numbers will be assigned to any ARCNET or MS/TP networks as required.

3. The Contractor shall contact the Computer Section for assignment, or confirmation, of the Network Number(s) to be used prior to beginning device configuration.

B. IP Address Assignments

1. Vassar maintains specially configured VLANs for the purpose of securely transporting BACS communication traffic. Address assignments are coordinated by the Computer Section.

2. The Contractor shall contact the Computer Section for assignment of IP addresses (and possibly non-standard UDP ports) prior to beginning device configuration.

3.6 BACNET ROUTERS

This clause provides requirements that are specific to the use of BACnet routers.

A. Error Message Destination

The Contractor shall configure each BACnet router to transmit network layer (routing) error messages to the EMCS.

END OF SECTION

SECTION 23 09 02
INTERGRATED ROOM AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete, integrated room automation system using wired or wireless technology for the following the following:

1. HVAC equipment
2. Lighting
3. Central electronic room access control
4. Central interface (CI) server application
5. Remote room monitoring and communications

B. RELATED WORK

1. Examine contract documents for requirements that affect work of this section. Other Specification sections that relate directly to work of this section include, but are not limited to:

a. Division 8--Door Openings
b. Division 23--Heating, Ventilating and Air Conditioning (HVAC)
c. Division 26--Electrical Power Wiring to System Hardware
d. Division 27--Communications
e. Division 28--Electronic Safety and Security
f. 33--Utilities.

C. SUBMITTALS

1. Product Data: Submit the Manufacturer's product data and installation instructions for each component and system.
2. Shop Drawings: Submit list of components and equipment to be supplied, including proposed locations, clearances and power requirements.
3. Operations and Maintenance Manual: Submit the Manufacturer’s standard operations and maintenance manual, including emergency maintenance provider.
4. Qualifications: Submit documentation from the Manufacturer and Installer indicating qualifications listed in Section 1.4, Quality Assurance.
5. Warranty: Submit the Manufacturer’s standard one-year labor and parts warranty for turnkey installation.

D. QUALITY ASSURANCE

1. Qualifications of Manufacturer: The Manufacturer shall have a minimum of 20 years documented experience manufacturing integrated room automation systems having similar or more stringent requirements than the system for the current project. The Manufacturer shall submit a list of at least 15 completed projects using similar integrated room automation systems.
2. Qualifications of Installer: Submit a letter signed by the Manufacturer stating that the Installer is licensed by or acceptable to the Manufacturer of the integrated room automation system.

E. DELIVERY, STORAGE AND HANDLING

1. Deliver materials and products in unopened, factory-labeled packages. Store and handle in strict compliance with the Manufacturer's instructions and recommendations. Protect from damage. Sequence deliveries to avoid delays, but minimize on-site storage.

F. COORDINATION

1. Conference: Convene a pre-installation conference to establish procedures to coordinate this work with related and adjacent work.
2. Coordination: Furnish inserts and anchors that must be built into other work. Work closely with installers of finish materials so that units are properly aligned with adjacent materials.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturer: INNCOM by Honeywell, 12 Clintonville Rd, Northford, CT 06472, USA. Tel:+1 (860)739-4468; www.inncom.com.

2.2 A. HVAC CONTROLS:

A. HVAC Type: The control strategy will be dependent on the type of HVAC equipment that is being proposed. The control equipment shall be compatible with most HVAC equipment with 5 relay control including WSHPs (Water Source Heat Pump). The following control strategies shall be applied:
   1. Water Source Heat Pumps (WSHP): The System shall control one WSHP in each room. The System shall directly control a 1-, 2-, or 3-speed, line-voltage or low-voltage interface. The System will also control the compressor and associated heating equipment. INNCOM will provide the WSHP Vendor with the necessary control card or connectors to be installed at point of manufacture or in the rooms. The System shall provide automatic switchover from heating to cooling operation at each room.
B. HVAC Control Strategies: Provision shall be made to prevent the system from switching repeatedly from cooling to heating and back while attempting to maintain a constant target temperature. The System’s temperature-control

performance shall meet the requirements defined below for proportional valves. The System's humidity-refresh performance shall meet the requirements defined below.

1. Temperature Control: The System in the room shall employ a PID algorithm to minimize fan speed and valve changes and to reduce servo-loop error. Such error, measured as the temperature difference between the set target temperature and the measured room temperature, shall not exceed 1.0°F (+/- 0.5°C) under steady-state conditions and will automatically compensate for changes in the heat/cooling load of the room. The temperature control algorithm shall be capable of using the full resources of the WSHP to maintain target temperature. Proportional-only algorithms that set the fan speed in proportion to the error shall not be accepted (as they cause a temperature control error that increases with the fan speed).
2. Humidity Refresh: The System in the room shall be capable of maintaining a maximum level of humidity. The refresh cycle will activate in unoccupied rooms only.
3. Humidity Refresh Cycle: The room air conditioning shall be activated on a pre-defined duty cycle to remove excess humidity. The System shall monitor, via central sensors or individual room sensors, the air temperature and relative humidity. When the relative humidity exceeds a preset threshold, the room AC shall be activated if the AC has been shut down for a period of time that exceeds a programmable time value (for example, if the AC has not run for the last one hour).
4. Fan Speed Control: Fan speed shall be selected automatically by the System to match the heat gain/loss in the room. Fixed-fan operation shall also be available to the guest. Fan speeds shall be field-programmable to allow limiting fan speeds to a desired range of speeds. For example, if the High Fan of the FCU is objectionable to the guest due to the noise level it creates, the System shall be capable of being programmed on a room-by- room basis to maintain Medium Fan speed and not enter into the High Fan speed under any condition. Fan operation shall be configurable to provide for "Continuous Fan" or "Automatic Fan." Continuous Fan means that the fan shall run even when the target temperature has been satisfied. Automatic Fan means that the fan shall run only on active heating or cooling call.
5. Multiple HVAC Zone Rooms (Suites): The System shall be capable of supporting multi-zone rooms, where the rooms are not separated by a door yet each room has multiple HVAC units. The System shall be able to link the thermostats and bedside panel (if provided) in these rooms so that they track. This prevents having one room call for heat while the other is calling for cooling.
6. Temperature History: The System shall have the capability to store the temperature, valve, and fan states for each room for at least three months, with all changes being reported.
7. Energy Conservation:
    a. The System shall provide optimized energy conservation measures with minimum inconvenience to the guest. At least four setback strategies shall be employed: two when a room is unrented (either occupied by staff or unoccupied), and two more when a room is rented (either occupied or unoccupied).
    b. The System shall obtain rented status automatically from the Property Management System (PMS). No manual data entry shall be required by the hotel to update the room-rented status.
    c. The System shall determine room occupancy automatically. The System shall keep the room status as occupied even while the guest is asleep.
    d. Setback values and related parameters shall be independently adjustable for rented and unrented modes. For example, a room may be declared unoccupied 15 minutes after door closure if rented and no motion was detected, but it may take only two minutes to return the room to the unoccupied mode if the room is unrented.

e. Reduced on/off switching during the night or “night setback” shall be available for implementation by choice of the property as a means to further reduce energy consumption while the guest is asleep.

f. The System will also implement setback strategies or cycle off HVAC equipment when exterior doors or windows are opened and the space is trying to maintain a target temperature. Switches will be applied to all active exterior windows and doors. They can be either wired or wireless.

g. The System shall also offer occupancy based lighting control which is coupled with a Master Light Switch installed by the entry door.

h. The System shall include peak demand controls that will interface with the Building Management System (BMS) or use an integrated peak demand limiting module. Load shedding strategies will be initiated in the following hierarchy: Unrented rooms will be set back first; then rented, unoccupied rooms; and finally rented, occupied rooms. Demand parameters and load shedding sequences shall be adjustable to allow for minimal guest discomfort while optimizing energy conservation efforts.

8. Digital Thermostat (Model E7): the unit shall be modular in construction so that each of the modules can be added at a later time if not installed initially.

a. The System shall include a wall-mounted, illuminated digital thermostat. The thermostat will be able to display current room temperature, target temperature, and outside temperature in degrees F and degrees C, as well as the humidity level.

b. The thermostat shall be easy to operate and shall allow changing the target temperature in steps of 1° F or 0.5° C. Clear indication shall be provided when the HVAC has been turned off.

c. The thermostat will support in-room voice control.

d. The thermostat shall provide proximity detection and a light sensor to provide a dynamic user interaction with dimmable display.

e. The thermostat shall have the capacity to work with a built-in Passive Infrared (PIR) motion sensor OR a remote PIR motion sensor OR combinations of both.

f. The thermostat shall be capable of directly controlling HVAC units operating on voltages ranging from 24VAC to 277VAC without the requirement of secondary control relays for the higher voltage applications.

g. The thermostat shall also be provided with an RF and Bluetooth transceiver that will allow remote control of lamps that are equipped with RF/Bluetooth receiving modules, an RF/Bluetooth capable Entry Light Switch, and the Electronic Door Lock (EDL).

h. The thermostat shall be connectable to the System via RF or a 2-conductor, low-voltage cable. The thermostat shall also have the capability of connecting to the HVAC equipment wirelessly via RF or Infrared signals.

i. The thermostat shall be capable of controlling HVAC units wirelessly RF (Zigbee-compatible) technology.

j. The thermostat shall have an ecoMODE® button that the guest can use to opt-in to the property’s sustainability practices.

k. The thermostat shall provide a SMART wall plate that captures room thermostat configuration to allow easy, no reprogramming thermostat replacement.

C. Lighting Controls:

1. Lighting control strategy is dependent on the building codes in effect at the location of the property and the period during which it is constructed, the intent of the lighting design, and the type of lighting fixtures or lamps being proposed. Most lodging lighting designs employ one or more of the following approaches:

a. Master Electrical Load Relay (X05B/X06): The high capacity relay by the entry door shall act as the automatic means of turning off all lights and switched receptacles within the guestroom and guestroom bathroom spaces, independently of one another. The relay shall respond to the signal sent from the thermostat-sensor within the guestroom and the occupant sensor within the guestroom bathroom to turn off the lights within the guestroom and guestroom bathroom, respectively.

b. Light Switch: The main light switch by the entry door shall turn off all lights and switched receptacles in the guestroom living space. The main light switch within the guestroom bathroom shall turn off all lights within the guestroom bathroom.

c. Thermostat-sensor: The built-in sensor within the Incomm thermostat shall detect vacancy of the guestroom space and send a signal to the guestroom relay to turn off all lights and switched receptacles within the space (after 20 minutes).

d. Bathroom Sensor: The Incomm sensor shall detect vacancy of the guestroom bathroom and send a signal to the guestroom relay to turn off all lights within the space (after 30 minutes).

2. Access Control: The System shall seamlessly integrate with select third party (Hafele, Saflok, Salto, TimeLox, or Vingcard) Electronic Door Locks (EDLs) to create a centrally controlled access control system. The integrated access system shall meet the following requirements:

a. Wireless Link: The EDL shall communicate with the System via an RF or Bluetooth wireless wall-mounted entry light, a wireless ceiling-mounted RF transceiver or a wireless wall-mounted RF transceiver or directly via RF/Bluetooth equipped thermostats.

1) If the locks are equipped with INNCOM approved RF or Bluetooth transceivers provided by the respective manufacturers, then the locks shall communicate with INNCOM RF/Bluetooth equipped room devices. The information packets shall be received from the locks and transmitted via the common INNCOM backbone network (wired or wireless).

b. Fast Response: The link between the System and the EDL shall provide a 0.5-second response time to meet the functional requirements defined herein.

c. EDL Battery Life: The addition of the required circuitry in the EDL to facilitate wireless communication with the System shall not materially reduce the service life of the batteries that power the EDL. Under no condition shall the service life be less than 18 months. A low battery warning shall be provided as a system alarm.

d. Door Status: The linked EDL shall report to the System any change in the status of the door opening. Such information shall be used by the System in its Occupancy logic, as defined herein. Note that said link shall alleviate the need for the installation of a separate door contact.

e. Staff Access Restriction: In addition to the normal staff access rights as controlled by the door locks, the EDL shall deny access to low-level staff cardkeys when a guest occupies the room.

f. Staff Access Cancellation: The System shall allow instantaneous cancellation of any staff card, without affecting the access rights of other staff cards. The cancellation shall take effect in specific rooms, a group of rooms, or the entire property within three seconds. The System shall automatically update the cancellation list in replaced locks to prevent access by unexpired, cancelled staff cards.

g. Guest Card Cancellation: The guest card shall be denied access to a room immediately upon the guest checkout, even if the card's date of expiration has not yet been exceeded.

h. VIP Guest Cards: The System shall accept pre-issued VIP cards for access to the guestroom. Authorization for the use of VIP cards shall be passed to the System from the Property Management System (PMS). The System shall transmit this authorization to the appropriate EDL.

i. Alarms and Reports: The System shall report the following exception conditions:

1) Low EDL Battery: The System shall generate a report of all EDL that have a low battery condition. Replacing the battery in the EDL will automatically clear the alarm condition in the central computer.

2) Door Open Too Long: The System shall generate an alarm if the guestroom door has been left open for a period exceeding a preset time-period.

3) Door Ajar: The System shall generate an immediate alarm if the guestroom door is partially closed, but not latched.

4) Access History: Every access or attempted access from any guestroom door shall be reported and stored within 15 seconds at the server level. This data shall be available for retrieval by date, room number, or card number from the EDL server. Staff card access information shall also be accessible for retrieval by staff member name.

j. Central Interface (CI) Server Application:

Each guestroom system or sub-system will communicate in real time with a central server running INNcontrol™3 application software shall provide a comprehensive list of room status information and alarms and shall also interface with other systems in the hotel, including the PMS and the Maintenance Management System (MMS).

1) PMS Interface: The software shall interface with the PMS computer through a serial link or TCP/IP. The PMS will provide the INNcontrol™3 software with current sale status of the guestrooms (rented/unrented and check-in/checkout). This information shall be transferred from the INNcontrol™3 software to the room within five seconds and will be used to determine the operation of the HVAC, lights, and other loads in the room. The INNcontrol™3 server shall also be linked and interfaced with the EDL server.

2) Management Display: The INNcontrol™3 application, or terminals connected to the INNcontrol™3 server, shall provide access to management to view and control such parameters as room temperature, room target temperature, HVAC operation, light control, and other conditions and statuses. In general, the INNcontrol™3 application shall provide access to any function of the room control system that is available to the guest in the room. The System shall be capable of interfacing with the Hotel Ethernet System via TCP/IP interface.

3) 3D Real-Time Display: The INNcontrol™3 application, or terminals connected to the INNcontrol™ 3 server, shall be able to provide a 3D view of real-time information such as door openings, guest interactions with room automation devices, and other events. The display shall display the property as an accurate representation of the property and the rooms shall be displayed in colors that represent the status of various devices in the rooms. The color display shall also show in gradients of color the aging of guest service requests and equipment alarms.

4) Remote Access/Diagnostics: The application shall provide full support of a remote terminal connected via TCP/IP to the server. The server software architecture shall be of a client/server structure. The remote terminals shall be PCs operating under Windows XP or later. The application shall be capable of running complete diagnostics of the System from a remote service center via dial-up phone lines or TCP/IP.

5) Alarm Outputs: The application software shall be programmable to route alarm conditions to a file, hard disk, third-party interface, or the PMS.

6) The user shall have the option of not logging on, which will allow View (read-only) use of the software, or logging on, which will allow Control functions based on the logon identification.

7) The software shall open to a pre-determined default language. It shall also be possible to choose another language available from the list.

8) The INNcontrol™3 application, or terminals connected to the INNcontrol™3 server, shall provide access to management to view and control such parameters as room temperature, room target temperature, HVAC operation, light control, and other conditions and statuses. In general, the INNcontrol™3 application shall provide access to any function of the room control system that is available to the guest in the room. The System shall be capable of interfacing with the Hotel Ethernet System via TCP/IP interface is opened is the 'Quick View' screen. Each guestroom selected for Quick View display shall be represented by a block on the screen. The block shall be numbered to correspond to the actual room number. The resulting menu shall allow the display of Butler calls, Valet requests, Pick-Up-Tray requests, Privacy/Service indications, SOS indications, and possibly one or two other requests if desired by the property—for example, cab request.

9) All service requests shall be displayed at once on the Quick View screen. The color coding shall allow easy recognition of each type of call.

10) The software shall display Housekeeping Calls to show a list of rooms requesting the indicated service. Other types of information shall also be optionally shown in the communication area, including clean/dirty room status, notifications, and issues to be handled by the front desk.

11) The software shall offer a Dynamic Suite Linking option and it shall display rooms that are linked as suites. The linked rooms shall be color-coded, and the type of link (common door or connecting door) shall be shown displayed in the room blocks.

12) The software shall be able to display as a minimum the following room conditions:

    a) Rented: Shows which rooms are currently rented.

    b) Occupancy: Shows which rooms are currently occupied, either by guests or staff.

    c) Rented + Occupancy: Shows which rooms are rented and occupied.

    d) Measured Room Temperature: Shows the temperature of each room on the block grid.

    e) Target Room Temperature: Shows the desired room temperature for each room on the block grid.

    f) AC Mode: Shows the operational status of the air conditioning system for all rooms on the block grid.

    g) Measured, Target and AC Mode: Shows all the above on the block grid.

    h) HVAC Equipment Operation: Shows heating, cooling and fan operation for each room on the block grid.

    i) Second Stage Operation: Shows forced, ready, active and normal status for each room on the block grid.

    j) Peak Demand/Load Shedding/Fire: Shows high, medium, low, and normal for peak demand/load shedding, and shows HVAC response to fire.

    k) Open Doors or Windows: Shows which rooms have open doors or windows.

    l) ETM: Shows rooms that have no energy management devices currently operating.

    m) VIP/Lowered Energy Management (LEM): Indicates room thermostat is not being controlled by the system.

    n) HVAC Trouble: Shows all rooms on the block grid with active HVAC alarms.

PART 3 - EXECUTION

3.1 GENERAL

A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.

B. Coordinate all control interconnects with all other trades.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Section covers water piping carrying water at 200ºF or less, used in the following systems:

1. Geothermal/Condenser water system
2. Solar thermal system

1.2 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Pipe
2. Accessories

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipe shall be new, free from scale or rust, of the material and weight specified under the various services. Each length of pipe shall be properly marked at the mill for proper identification with name or symbol of manufacturer.

B. All steel piping, except where otherwise rated, shall be standard or extra strong weight, in conformance with the ASTM A-53 Grade B seamless.

C. All brass piping shall be standard or extra heavy weight 85% red brass semi-annealed seamless-drawn, in conformance with the ASTM B-43, as manufactured by Anaconda, American Brass Co., Chase Brass and Copper Co., or Revere Copper and Brass, Inc.

D. All copper tubing shall be of weight as required for service specified, with conformance with ASTM B-88 for Type "L" and "K" tubing, as manufactured by Chase, Anaconda, Revere, or approved equal. Tubing and fittings shall be thoroughly cleaned with sand cloth and treated with an approved non-corrosive flux before solder is applied.

E. All galvanized steel piping shall be standard or extra strong weight, as specified, in conformance with the ASTM A-53 Grade B. Pipe shall be hot-dripped zinc-coated with Prime Western smelter and not wiped.

F. Fittings shall be of material conforming to the following schedule:

1.	Malleable Iron Fittings	ASTM A-197
2.	Cast-Iron Fittings	ASTM A-126
3.	Brass Fittings	ASTM B-62
4.	Solder Fittings	ASTM B-88
5.	Steel Welding Fittings	ASTM B16.9.
6.	Wrought Copper	ASTM B16.22

G. Dielectric Fittings: Install dielectric nipple, coupling or flange, to prevent galvanic action between ferrous and non-ferrous piping. Dielectric fittings shall be accessible for inspection and service. Provide dielectric fittings at all connectors to dissimilar metals, including at air handling unit coil connections.

H. All fittings used at expansion loops or bends shall be extra heavy.

I. Cast-iron, malleable-iron, and bronze fittings shall be of Crane manufacturer or approved equal.

J. Flanges shall be raised face, of the same weight as the fittings in each service category. All flanges shall be drilled to "US Standard" hex nuts and washers. Bolting shall conform to ASTM 193 Grade B-7, threads Class 7 fit. Nuts shall be semi-finished hexagonal, ANSI B18.2 ASTM A194 Grade 2H.

K. Provide permanent signage on expansion tank of hydronic systems treated with chemicals that include the chemical type, concentration system volume and direction to drain to sanitary drain.

2.2 PIPE AND FITTINGS

Piping Types and Materials

Service & Location	Pipe Size	Pipe Material & Weight	Joint Type	Fitting Material
Solar Thermal Water (<250°F)				
Inside Building	3" or smaller	Copper, Type L, ASTM B88	Soldered below 175 PSI, Brazed above 175 PSI	Wrought Copper
	4" or larger	Steel, Schedule 40, ASTM A53, Type S, Grade B	Welded	Steel
Outside Building	3" or smaller	Copper, Type L, ASTM B88	Soldered below 175 PSI, Brazed above 175 PSI	Wrought Copper
	4" or larger	Steel, Schedule 40, ASTM A53, Type S, Grade B	Welded	Steel
Geothermal/Condenser Water				
Inside Building	3" or smaller	Copper, Type L, ASTM B88	Soldered below 175 PSI, Brazed above 175 PSI	Wrought Copper
	4" or larger	Steel, Schedule 40, ASTM A53, Type S, Grade B	Welded	Steel
Outside Building	3" or smaller	Copper, Type L	Soldered below 175 PSI, Brazed above 175 PSI	Wrought Copper
	4" or larger	Steel, Schedule 40, ASTM A53, Type S, Grade B	Welded	Steel
Below Ground	All Sizes	See Geothermal Spec	-	-
Refrigerant				
Inside Building	All Sizes	Copper Tube, Type ACR, ASTM B280	Brazed (silver solder (45% min cadmium free)	Wrought Copper, 300#
Outside Building	All Sizes	Copper Tube, Type ACR, ASTM B280	Brazed (silver solder (45% min cadmium free)	Wrought Copper, 300#

Air Conditioning Coil Condensate				
All Locations	All Sizes	Copper, Type M, Drawn, ASTM B88	Soldered	Wrought Copper

2.3 PRESS FIT JOINING SYSTEM

A. Manufacturer

1. Design Basis: Viega ProPress
2. Other acceptable manufacturers:
   a. Elkhart Products, Express

B. Material

1. Press Fittings: Copper press fittings. Must comply with ASME B16.18 or B16.22.
2. O-Rings: EPDM
3. Fittings shall be rated for 0°F to 250°F, and 250 psi.

C. Application

1. Locations where Engineer has determined that traditional hot joining methods are not possible at a specific location.

D. Press-Connect Fitting: Copper press-connect fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 O-rings for copper press-connect fittings shall be EPDM.

E. Copper press-fittings shall be installed in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and marked at the end of the fittings. The fitting alignment shall be checked against the mark on the tubing to insure the tube is fully engaged (inserted) in the fittings. The joints shall be pressed using a pressing tool and jaws, or jaw set, approved by the manufacturer.

F. Alignment of the correct area on the fittings with the corresponding correct area of a crimping sling is critical.

When the installer has confirmed that positioning and alignments are correct and other proper installations procedures have been followed, crimping can take place with the band remaining in the groove.

Installer shall use manufacturer provided alignment and dimension guides or employ equivalent measures when none are provided by manufacturer.

G. Tools used to complete joint shall be manufacturer approved for the fitting being installed.

2.4 WELDING PIPING AND FITTINGS

A. All fittings for welded piping shall be as manufactured by Tube Turn, Anvil, Bonney Forge or equal as approved by the Architect. The fittings shall be of the same weight and material as the piping to which they are attached.

B. For piping 3" and larger, full size branch connection shall be made with manufactured welding tees, branch connections for less than full size, shall be made with welding tees or with Weldolet forged branch outlet fittings. Fishmounting, shaped nipples, and stubbing not permitted.

C. Welding outlet fittings shall be Weldolets as manufactured by Donney Forge, Inc., or approved equal 2 or 3 and smaller branches shall be made with thredolets as made by Bonney Forge or approved equal.

D. Welding fittings shall be of the same material and schedule as the pipe to which they are welded. Welding elbows shall be long radius pattern unless clearance conditions necessitate the use of standard radius pattern. Welding fittings shall be as made by Tube-Turn.

E. All flanges shall be welding neck flanges ANSI B16.5 ATM 181 Grade I. All systems, except where otherwise noted - 150 lbs. Class, forged steel.

2.5 STRAINERS

A. Manufacturers:

1. Design Basis: Armstrong
2. Other Acceptable Manufacturers:
   a. Mueller
   b. Sarco
   c. Hoffman
   d. Dunham Bush

B. Size 2" and Smaller: 250-lb cast iron, threaded.

C. Size 2½" and Larger: 125-lb cast iron, flanged.

D. Screens:

1. Final Screen:
   a. Material: Type 304 stainless steel.
   b. Perforations: 0.045" diameter, 233 holes per square inch.
2. Roughing Screen:
   a. Material: Carbon steel.
3. Provide roughing screens at all circulation pumps and at any additional strainers upstream of primary plant equipment such as boilers, chillers, etc.
4. Screen shall be removable without removing piping.

2.6 EXPANSION TANKS

A. Manufacturers:

1. Design Basis: Amtrol Inc.
2. Other Acceptable Manufacturers:
   a. ITT Bell & Gossett
   b. Taco
   c. GFC Corp
   d. J.J. Finnigan
   e. Woods
   f. Wessels

B. Type: Bladder

C. Design Temperature: Per schedule

D. Maximum working pressure: Coordinate with pressure of system

E. Design pre-charge pressure: Same as boiler make-up water PR fill valve.

F. Bladder or Diaphragm Material: EPDM, compatible with propylene glycol.

2.7 AIR PURGERS

A. Manufacturers:

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Amtrol
   b. Taco
   c. Thrush

B. Model: 107

C. Float actuated, non-modulating, rated at 250 psig at 250ºF.

2.8 AIR VENTS

A. Manufacturer:

1. Design Basis: Amtrol
2. Other Acceptable Manufacturers:
   a. Bell & Gossett
   b. Taco
   c. Thrush
   d. Armstrong

B. Resilient Parts: EPDM

C. Vents on Pipes Size 2" and Smaller: Model 706

D. Vents on Pipes Size 2½" and Larger: Model 706

E. Vents on Air Purgers: Model 706

F. Provide manual air vents on system high points located in finished spaces, on all systems that contain glycol, and on all chilled water systems.

G. Provide automatic air vents on water system high points located in unfinished spaces.

H. Air vents shall be a minimum of ½" and furnished with brass hose connectors and cap.

2.9 PRESSURE REDUCING FILL VALVES

A. Manufacturers:

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Taco
   b. Thrush
   c. Watts

B. Size: ¾"- for systems up to 300 gallons
   1" - for systems larger than 300 gallons

C. Model:

1. 8 psig to 25 psig: No. 12

2. 25 psig to 60 psig: No. 7

2.10 PRESSURE TEMPERATURE TAPS

A. Manufacturers:

1. Design Basis: Sysco
2. Other Acceptable Manufacturers:
   a. Universal Lancaster, Inc.
   b. Petes Plug

B. Model: BNO-500, ¼" NPT, or ½" NPT.

C. Construction:

1. Body and Cap: Brass
2. Pressure: 500 psig
3. Temperature: 350ºF
4. Core: Hot water – EDPM, Glycol – EPDM, Chilled Water – Neoprene, Cold Water - Neoprene
5. Cap: Gasketed, threaded.

D. Thermometer:

1. Number required: 1
2. Dial diameter: 2"
3. Range: 0º to 220º

E. Pressure Gauge Adapter:

1. Number required: 1
2. Model: GA-125

F. Pressure Gauge:

1. Number required: 1
2. Dial diameter: 4½"
3. Range: 0 to 100 psig
4. Accuracy: ½%

G. Provide manual vents (accessible from floor) piped to sinks or floor drains for all glycol systems. This may result in significant lengths of pipe.

2.11 THERMOMETERS

A. Manufacturers:

1. Design Basis: American, Trerice
2. Other Acceptable Manufacturers:
   a. Ernst
   b. Marsh
   c. Marshalltown
   d. Weksler
   e. Weiss

B. Housing: 9" adjustable angle stem.

C. Tube: Lens front, red liquid.

D. Range:

1. Geothermal/Condenser water, 0ºF to 120ºF.
2. Solar Thermal, 30ºF to 240ºF.
3. Dial thermometers shall be 5 inch hermetically sealed, bimetal with stainless steel cases, antiparallax dials with raised jet black figures, stainless steel stems, and brass separable sockets unless otherwise specified. Thermometers for duct mounting shall have union connections in lieu of separable sockets. Separable wells shall be stainless steel for steel pipe and brass for copper pipe. Separable wells shall be standard type for uninsulated pipe and locking extension type of proper length for insulated pipe. Stem shall extend a minimum of 2-1/2" into the fluid.

E. Thermometers for duct mounting shall have union connections in lieu of separable sockets. Separable wells shall be stainless steel for steel pipe and brass for copper pipe. Separable wells shall be standard type for uninsulated pipe and locking extension type of proper length for insulated pipe. Stem shall extend a minimum of 2-1/2" into the fluid.

F. The accuracy of all thermometers shall be within 1% of the scale range.

G. Thermowells: All thermowells for steam service shall be stainless steel and for water service shall be brass. Thermowell length shall be in accordance with ISA standards and shall include the appropriate extension to allow for pipe installation. Extension neck shall be included when required to match thermowell and insulation thickness.

H. Locking adjustable angle body and a case of aluminum or non-metallic material. Thermometer shall be secured to well by tapered bushing and not by set screws. Provide the following characteristics:

1. Scale Graduations: 2˚F.
2. Range: Select to provide a mid-scale reading at normal operating temperature.
3. Accuracy: 1%.

I. Industrial light-powered digital thermometer with adjustable-angle stem and a case of aluminum or high impact ABS plastic. Thermometer shall be secured to thermowell by tapered bushing and not by set screws. Installation shall insure that thermometer is accessible and has been adjusted to be readable from a 5-foot level as viewed from the floor. Display shall be LCD with digits a minimum of 0.5-inch high with the following characteristics:
1. Resolution :0.1 °F.
2. Range; -40 to 300 °F.
3. Sensor: Glass passivated thermistor.
4. Accuracy: 1%

J. Acceptable Manufacturers

1. Trerice
2. Weiss Instruments
3. Weksler

2.12 PRESSURE GAUGES

A. Design Basis: Trerice

1. Other Acceptable Manufacturers:
   a. Ernst
   b. Marsh
   c. Marshalltown
   d. Winters
   e. U.S. Gauge
   f. Weksler

g. Ashcroft
h. Or approved equal.

B. Model: 800LF Series. Liquid filled.

C. Dial Face 4½ inch diameter; 270º arc.

1. Range: As required to keep normal operating point in mid 2/3 to ¾ of dial.
   a. Use 30" vacuum to 100 psi gauge for pumps designed to operate at pressures up to 75 psig total pressure. (Total pressure = required pump-off static pressure plus scheduled pump head).
   b. Geothermal/Condenser water: 0 to 100 psig.
   c. Solar Thermal water: 0 to 100 psig.
   d. Discharge side of water pressure reducing valve: 0 to 100 psig.

2. Use higher pressure ranges as required such that scheduled total pressure does not exceed an operating point above ¾ range of dial.

D. Accuracy: 2% of full scale over middle of range.

E. The gauges shall have silicone filled stainless steel casings with chrome plated bezels or rims. The gauges shall have white faces with black filled engraved numerals and adjustable pointer. The diameter of the dial shall not be less than 3-1/2 inches. Gauges shall have brass bronzed brushed rotary type movement.

F. Provide isolating ball valve, not a gauge cock.

2.13 FLOW MEASURING DEVICES (ANNULAR/VELOCITY AVERAGING)

A. Manufacturers:

1. Design Basis: Veris
2. Other Acceptable Manufacturers:
   a. Presso
   b. Barco Division
   c. Aeroquip Corp.

B. Accessories:

1. Stop valves
2. Quick disconnects
3. Caps

C. This shall be a coordinated system, including Venturi flow stations and portable master meter, supplied by one manufacturer. Each Venturi station shall be complete with pressure tap nipples, quick disconnect valve and safety shut-off valves, indented metal identification tag on chain, giving pipe side, Venturi series, station identification, and meter reading at specified flow rate. Venturi stations shall be one piece brass screwed 1/2" through 2". Sizes 2-1/2" through 8" shall consist of plated cast iron Venturi insert held between specially machined self-centering 150# steel weld neck units. Sizes 10" and larger shall be fabricated steel plated, with welding ends. Venturi size and series shall be selected so that design flow rate shall be between 10" and 40 inches of water pressure differential on a 0-50" meter with permanent pressure loss of not more than 10% indicated flow rate differential pressure. Minimum flow rates of 2-1/2 FPS are permissible. Venturi stations shall be compatible with temperatures and pressure of the system.

D. Master meter shall consist of 6" round dial, dry type meter supplied with scale reading zero to 50 inches of water differential pressure and shall be mounted in a portable water and rot-proof fiberglass carrying case complete with 10 ft. lengths of 1/4" high pressure high temperature connecting hose, quick disconnect socket valves, venting valves, installation and operating instructions and capacity curves. Master meter shall become property of the Owner.

E. Master Meter shall be high pressure, high temperature type rated at 50 psig and 400F, Venturi looseleaf charts shall be supplied for correction to master reading for HTHW.

2.14 FLOW MEASURING DEVICES (TURBINE)

A. Manufacturers:

1. Design Basis: Onicon
2. Other Acceptable Manufacturers: Approved equivalent

2.15 POT FEEDERS

A. Manufacturers:

1. Design Basis: H-O-H
2. Other Acceptable Manufacturers:
   a. Dearborn

B. Model: HV

C. Size: 2 gal.

2.16 AIR SEPARATORS

A. Manufacturers:

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Taco
   b. Spirotherm

B. Model: “Rolairtrol”

C. Constructed and nameplated for 125 psig working pressure and stamped in compliance with ASME boiler and pressure vessel code.

D. Provide blow-down connection.

2.17 AUTOMATIC FLOW CONTROL VALVES (AUTOMATIC BALANCING VALVES)

A. Flows Under 3 gpm:

1. Manufacturers:
   a. Design Basis: Flow Design Inc.
   b. Other Acceptable Manufacturers: Hayes
2. Pressure Drop Range: 15 to 150 psi.

B. Flows 3 gpm or Greater:

1. Manufacturers:
   1) Design Basis: Flow Design Inc.

   Other Acceptable Manufacturers:
   2) Autoflow
   3) Griswold
2. Type: Spring loaded piston.

3. Materials and Connections: Match pipes.
4. Pressure Drop Range: 2 to 40 psi.

C. Body: DZR brass, optional Y or T body construction to allow removal of flow cartridge without breaking main piping

D. Optional Integral Shutoff:

1. Ball: Chrome plated or stainless steel
2. Stem: blowout proof wit EPDM O-ring and adjustable Teflon packing nut, optional stainless steel as well as extensions for insulation
3. Seat: Reinforced TFE
4. Handle Style: Steel lever, optional reinforced plastic tee handle for vapor seal

E. End Connections: Threaded or sweat as required. Return side shall have union connection

F. Pressure Gage Connections: Dual Pressure Temperature test ports, brass body EPDM internal seals with retained safety cap, rated 1000 PSI at 275 F. Optional extensions for insulation

G. Flow Cartridge:
1. Body: Series 300 Stainless Steel wear surface, CNC machined piston and cylinder
2. Spring: Stainless Steel
3. Calibration: Integral adjustable factory set threaded locking nut to calibrate spring compression for design flow performance throughout spring range.

H. CWP Rating: 400 PSIG

I. Maximum Operating Temperature: 250 F

J. Accuracy: Factory pre set flow +-5% over defined pressure differential range or spring range as defined by manufacturer and determined by pump head calculations.

K. Factory Test:
1. Performance: 100% spring test of all flow control cartridges at the factory to verify design performance.
2. Leak Test: Every complete valve, factory leak tested at 100 psi under water

2.18 RELIEF VALVES

A. Manufacturers:

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Taco
   b. Thrush
   c. Watts

B. Type: ASME

C. Size: Maximum input capacity of system at design pressure.

D. Setting: Operating pressure of system plus 2 psi.

2.19 GEOTHERMAL DISTRIBUTION MANIFOLDS

A. Material:
1. High density polyethylene, type PE4710, ASTM D3035, DR 11.
2. Comply with ASTM D 3035 with minimum working pressure rating of 200 psi at 73 degrees F.

3. ASTM D3350 cell classification PE445574C
4. Long Term Hydrostatic Design Basis: 1600 psi at 73 degrees F, when tested in accordance with ASTM D2837; appropriate listing in current edition of PPI TR-4 will constitute evidence of compliance with this requirement; otherwise, submit independent test results.

B. Joints and Fittings:
1. Polyethylene of same type as pipe, of sizes and types suitable for the pipe being used; use only heat fusion or stab-type mechanical fittings that are quality controlled to provide a leak-free union between piping ends that is stronger than the piping itself. Do not use other barbed fittings or hose clamps.
a. Electrofusion Type Fittings: Comply with ASTM F1055.
b. Butt Fusion Fittings, 1-1/2" pipe and above: Comply with ASTM D3261.

C. Holes shall be tapped for connections. Outlet ports shall be fusion welded onto the body of the manifold, with integrated fittings for connection to the borehole field. Fusion welding shall be done in a factory setting to ensure quality of the manifold.

D. Manifold shall be pressure tested and with no indication of leaks.

E. Balancing Manifolds

1. Manifolds shall be equipped with supply and return manifold butterfly isolation valves, pressure gauge, thermometer, and air vent/fill ports.
2. Each circuit shall be supplied with circuit supply and return isolation valves, supply balancing valve, and P&T yap.

2.20 PROPYLENE GLYCOL

A. Manufacturers:

1. Design Basis: Dow Chemical Company
2. Other Acceptable Manufacturers:
a. Dupont

B. Model: Dowfrost

C. Type: Propylene Glycol based with corrosion inhibitors.

2.21 VENTURIS

A. Manufacturers:

1. Gerand
2. Barco
3. Presso

B. Identification:

1. Provide engraved metal tag indicating Beta Ratio or flow curve.
2. Hang on chain to clear insulation.

C. Size:

1. Select Beta ratio to provide 10" to 30" water gauge meter reading.

2.22 EXPANSION COMPENSATORS, TWO INCH AND SMALLER

A. Manufacturers - Design Basis: Flexonics

B. Other Acceptable Manufacturers:

1. Adsco
2. Keflex
3. Metraflex

C. Stroke: ¼" extension, 1¾" compression.

D. Model: HB-XXX-FFS for copper tube, all bronze.

E. Model: H-XXX-MMT for steel pipe with stainless steel bellows, steel shroud and fittings.

2.23 FLEXIBLE PIPE CONNECTORS

A. Manufacturers - Design Basis: Mason

1. Other Acceptable Manufacturers:
   a. Metraflex
   b. Flexonics
   c. Victaulic
2. Model: MFTNC, Twin Sphere 225 psi.

B. Pipe Alignment Guides:

1. Manufacturers - Design Basis: Flexonics
2. Other Acceptable Manufacturers:
   a. Adsco
   b. Keflex
3. Model: PG
4. Material:
   a. Spider: Steel for steel pipe, bronze for copper tubing.
   b. Ring: Steel
   c. Travel: 3"

C. Victaulic Style 177, 75, or 77 flexible couplings may be used in lieu of flexible connectors for vibration isolation and noise reduction at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.

2.24 SLEEVES

A. Steel-Pipe Sleeves: Fabricate from Schedule 40 steel pipe. Remove burrs.

B. Iron-Pipe Sleeves: Fabricate from service weight cast-iron pipe. Remove burrs.

C. Sheet-Metal Pipe Sleeves: Fabricate from galvanized sheet-metal, closed with lock-seam joints.

1. For following pipe sizes, provide gauge indicated:
   a. Three Inch Pipe and Smaller: 20 gauge
   b. Four Inch to Six Inch Pipe: 16 gauge
   c. Over Six Inch Pipe: 14 gauge

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine location where these specialties are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install HVAC Specialties where shown, in accordance with manufacturer's written instructions and with recognized industry practices, to ensure that HVAC Specialties comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of HVAC Specialties with other components of systems.

C. All coils and heat exchangers shall be equipped to measure and adjust flow. Adjustable valves with flow measuring taps are preferred. The balancing valve shall not be used for coil isolation--provide ball or butterfly isolation valves in addition to the balancing valves.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of HVAC Specialties, test HVAC Specialties to demonstrate compliance with requirements. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 PIPE INSTALLATION

A. Install horizontal piping level (except drain piping and as otherwise noted) and parallel to building construction. All vertical piping to be plumb.

B. Make any changes in direction with fittings, do not kink or bend piping. Elbows are to be long radius type wherever possible.

C. Regardless of how shown on schematic piping diagrams, do not install a tee so that flow enters from opposite directions.

D. Do not rearrange piping in a manner to increase pressure drop without written approval from Architect/Engineer.

E. Install drains with cap and brass hose connector at all low points and traps of the system.

F. Vent piping from the high temperature hot water system shall comply with all requirements of high temperature hot water piping specified herein before. This shall also apply for the high temperature water safety valve discharge piping.

G. General:

1. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure.
2. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly, maintenance or replacement of valves and equipment.
3. Reduce sizes by use of reducing fittings.
4. Install piping without springing or forcing.
5. Provide sufficient swing joints, anchors, expansion loops and devices necessary to permit free expansion and contraction without causing undue stresses.

6. Support piping independently at equipment so its weight will not be supported by the equipment.
7. Support piping to maintain a consistent slope as indicated on the drawings without sagging or pocketing of any kind. Where not otherwise indicated, all horizontal piping shall slope a minimum of 1/16 inch per foot to drain at system low points.
8. Provide air vents at high points of all pumped piping systems. Provide drains at all low points and traps.
9. Install horizontal piping parallel to building construction, make any changes in direction with fittings.

H. Location:

1. Locate piping runs, except as otherwise indicated, both vertically and horizontally to allow for complete drainage of piping system (pitched to drain).
   a. Avoid diagonal runs wherever possible.
   b. Orient horizontal runs parallel with walls and column lines.
2. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of the building.
   a. Limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any.
   b. Where possible, locate insulated piping for 1.0" clearance outside insulation.
3. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings.
   a. Do not encase horizontal runs in solid partitions, except as otherwise indicated.

I. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures.

1. Exception: where shown on drawings or where accepted by the Engineer, provide drip pan under piping, and conform to NEC.
2. In no case shall piping run directly above transformers, electrical panels or switchgear.

J. Unless otherwise specified, all flanged joints shall be fitted with Manville or equal ring gaskets designed for the intended service.

K. Coordinate with other work as necessary to interface installation of piping with other components of systems.

L. Provide and erect in a workmanlike manner, according to the best practices of the trade, all piping shown on the Drawings or required to complete the installation intended by these Specifications.

M. All piping taps shall be from the top of the pipe unless approved by the Engineer.

N. The Drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions and to provide adequate maintenance room and headroom in the Mechanical Rooms.

O. Study the General Construction Specifications and Plans, of the exact dimension of finished work and of the height of finished ceilings in all rooms where radiation, units, equipment or pipes are to be placed and arrange the work in accordance with the Schedule of Interior Finishes, as indicated on the Architectural Drawings.

P. All exposed piping shall be run perpendicular and/or parallel to floors, interior walls, etc. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance. All valves, controls and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.

Q. All pipe lines made with screwed fittings must be provided with a sufficient number of flanges or unions to make possible any taking down of the pipes without breakage of fittings.

R. All piping shall be erected as to insure a perfect and noiseless circulation throughout the system. No bull head tees will be permitted.

S. All valves and specialties shall be so placed as to permit easy operation and access.

T. Provide proper provision for expansion and contraction in all portions of pipework, to prevent undue strains on piping or apparatus connected therewith. Provide double swings at riser transfers and other offsets wherever possible, to take up expansion. Arrange riser branches to take up motion of riser.

U. Approved bolted, gasketed, flanges (screwed or welded) shall be installed at all apparatus and appurtenances, and wherever else required to permit easy connection and disconnection. Screwed unions shall be used on piping 2 ½ " or less.

V. All piping connections to coils and equipment shall be made with offsets provided with screwed or welded bolted flanges so arranged that the equipment can be serviced or removed without dismantling the piping.

W. If, after plant is in operation, any coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be repiped with approved and necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

X. Fittings shall be of the eccentric reducing type, where changes of size occur in horizontal piping to provide for a proper drainage or venting. Steel pipe bends shall be made of the very best grade open hearth, low carbon steel, leaving uniform exterior and interior surface. Pipe bends shall be made with seamless steel pipe, having a minimum radius of not less than five (5) pipe diameters.

Y. Tubing shall be erected neatly in a workmanlike manner. Bends in soft copper tubing shall be made by benders to prevent deformation of the tubing in the bends. Approved seat-to-pipe threaded adapters shall be provided for junctions with valves and other equipment having threaded connections.

Z. Vertical sections of main risers shall be constructed of pipe lengths welded together. No couplings shall be used.

AA. The ends of all pipe and nipples shall be thoroughly reamed to the full inside diameter of the pipe and all burrs formed in the cutting of the pipe shall be removed.

BB. Piping shall be installed in accordance with the latest edition of the ASME Code for Pressure Piping.

CC. All piping shall be concealed above furred ceilings in rooms where such ceilings are provided (except where specifically indicated otherwise on the drawings, or in walls or partitions, except as otherwise indicated).

DD. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

EE. Pipe nipples - Any piece of pipe 3" in length and less shall be considered a nipple. All nipples shall be extra heavy. Only shoulder nipples shall be used. No close nipples will be permitted.

FF. Screw threads shall be cut clean and true; screw joints made tight without caulking. No caulking will be permitted. A non-hardening lubricant shall be used. No bushings shall be used. Reductions, otherwise causing objectionable water or air pockets, to be made with eccentric reducers or eccentric fittings.

GG. Provide vents with hose connector and cap at all high points.

3.5 WELDING

A. Before any operator shall perform any pipe welding, also submit the operator's qualification record in conformance with provisions of the code having jurisdiction, showing that the operator was tested and certified under the Procedure Specification as before mentioned.

B. Welding:

1. Conform to the latest revision of the applicable code, whether it is the ASME Boiler and Pressure Vessel Code, Code for Pressure Piping ANSI B31, or such state or local requirements as may supercede codes mentioned above.
2. All pipe welding operators shall comply with the requirements of the American Welding Society.
3. Machine cut and bevel piping ends for v-type joints.
4. Use recommended bevels and spacing between ends of pipe to assure full penetration complete to inside diameter of pipe.

C. Welded Joints:

1. Will be observed visually by the Architect/Engineer.
2. Any weld judged defective from a visual observation, shall be ordered tested at the expense of the Contractor or chipped out for full depth and re-welded.
3. Welded joints shall be x-rayed at a frequency determined by ASME codes. Welds that prove deficient shall be chipped out to full depth and replaced.

D. Welding Fittings:

1. Unless otherwise noted, make all changes in direction and branch take offs with manufactured fittings.
   a. Use long radius (R=1.50) fittings wherever possible.

2. Shop Fabricated Fittings:
   a. Branches more than two pipe sizes smaller than main line may be made with "weld-o-let" type pre-manufactured saddle fittings.
   b. Where specifically allowed by the Engineer, angles of less than 22½° and branch piping from headers may be made by shop fabricated or manufactured metered fittings.
   c. Submit shop drawings.
   d. Thoroughly clean fittings to remove slag.
   e. Fittings shall be available for observation by the engineer prior to installation.
3. In no case will field made miters or weld-o-let fittings be allowed. Exception: Temperature control wells and water treatment taps may be made with weld-o-let fittings in pipe 3" or larger in diameter.

E. Installation

1. Weld ells shall have a center line radius not less than diameter of the pipes.
2. Instrumentation connections 3/4" and smaller on all systems shall be provided by welding threaded 2000# forged steel half couplings to the pipe.
3. All pipe to be welded shall be cut off clean and beveled. All welding shot shall be removed.
4. Composition of welding electrodes shall be in accordance with manufacturer's recommendations.
5. Assume responsibility for the quality of welding done and repair or replace any work not in accordance with these specifications.
6. Cut weld test plugs at locations selected at random by the Architect. The test plugs shall be tested by the testing agency approved for this project. Failure of the test plugs to meet the standards of the specified codes and agencies shall result in the complete removal and replacement of the joint and retesting of the operator who performed the welding. The removal and replacement of the joints shall be at no additional cost to the Owner.

3.6 COPPER TUBING JOINTS AND FITTINGS

A. Unless otherwise noted, make all couplings, changes in direction, branch outlets, and transitions to other materials or joining methods with standard manufactured fittings.

B. Do not expand or swage piping in lieu of proper solder fittings.

C. Do not extrude or “pull” branch outlets with “tee-drill” type equipment.

D. Do not use self tapping type branch outlets.

1. See “hot taps” below.

3.7 THREADED JOINTS AND FITTINGS

A. All threaded joints shall be made in accordance with American National Standard B2.1.

1. Do not overthread pipe.
2. Apply pipe joint compound on male threads only.
3. Do not use right and left hand threaded joints to make a “union”.

B. Do not thread steel pipe schedule 10 or lighter.

1. UL listed light wall pipe may be threaded in accordance with its listing.

C. Screwed Piping

1. All connections to apparatus with screwed piping shall be made with 250 pound brass seat unions.
2. All screwed nipples shall be Schedule 80 nipples.

3.8 PRESS FIT SYSTEMS

A. Fittings and piping shall be joined in accordance with manufacturer’s installation guidelines.

1. Tubing shall be fully inserted into fitting.
2. Mark all tubes at shoulder of fitting.
3. Press joints using manufacturer approved tool.

B. All press fit systems shall have a preliminary water pressure test at 50 psi to confirm all fittings are properly pressed. This test is in addition to the that required by the system.

3.9 POLYETHYLENE PIPING

A. Join piping and fittings using heat fusion or electrofusion; do not use solvents, adhesives, or mechanical fittings.

B. Provide flanges or unions to connect heat exchanger piping to equipment or piping of different type; locate all transitions between piping of different types inside the building or otherwise accessible (i.e. above grade).

C. Keep dirt and debris out of pipe assemblies; cap or plug open ends until connected to adjacent piping.

D. Do not bend piping to shorter radius than recommended by pipe manufacturer; do not kink piping; use elbow or other fittings for sharp bends.

3.10 EQUIPMENT CONNECTIONS

A. Do not allow weight of piping or expansion of piping to put stress on equipment connections.

B. Pipe equipment to allow for servicing (coil pull, tube pull, etc.) with minimum of disruption to piping.

C. Provide unions or flanges at all equipment connections.

3.11 FREEZE PROTECTION

A. Fill systems with indicated solution by volume of propylene glycol and water.

B. Pre-mix all solutions before injection into system.

3.12 AIR VENTS

A. Install automatic air vents at high points.

B. In installing water piping systems and all equipment, carefully plan the actual installation in such a manner that high points and air pockets are kept to a minimum and are properly vented where they are unavoidable. All air elimination devices called for on the Drawings and in these Specifications shall be provided and properly installed. In addition, furnish and install all other air elimination devices which may be required due to job conditions. Assume responsibility for a proper, continuous and automatic air elimination to assure even and balanced distribution of water to all equipment.

3.13 RELIEF VALVES

A. Install pressure relief valves on all vessels, which may be isolated from other relief valves by closing valves. Pipe discharge full size to nearest floor drain.

3.14 PRESSURE TEMPERATURE TAPS

A. In Pipes 2” and Smaller: Install taps in tee at change in direction so inserted thermometer stem will be parallel to center line of pipe.

1. Add extra change in direction if necessary.
2. Allow clearance for insertion of thermometer.
3. Insure that gauge or thermometer will be in a readable position.

B. Furnish and install in each supply and return runout to each reheat coil and where indicated on the Drawings, a 1/4" MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with valve core of Nordel (Max. 275˚F), fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig.

C. In addition, the installing contractor shall supply the Owner with six pressure gauge adapters with 1/8" OD probe and 6 five inch stem pocket testing thermometers; 25-125˚F for chilled water and six 50-500˚F for hot water.

D. Provide one pressure and temperature test kit consisting of one 0-60 PSI, water pressure gauge and one 0-30 psi water pressure gauge each with no. 500 gauge adapter attached, a 25-120˚F pocket testing thermometer, a 0.220 F. pocket test thermometer, a No. 500 gauge adapter, and a protective carrying case. Provide one additional 0-60 psi pressure gauge and one additional 0 - 30 psi pressure gauge.

E. Test kit shall be used by the Balancing Contractor to balance the systems and then it shall be turned over to the Owner.

F. Test stations and test kit shall be manufactured by Paterson Engineering Company, Inc. or approved equal.

3.15 HOT TAPS

A. Installing a branch line in piping while under service or static pressure (hot taps) shall only be done where specifically authorized

B. Submit the proposed method of procedure for each fluid service and pipe material.

1. Hot tap procedure shall remove a plug of main tap material and retrieve it. The plug shall be a maximum of 1 pipe size smaller than the branch size. Hang the removed plug by a chain at the completed tap.
2. Hot tap procedure shall not affect the temperature or pressure rating of the piping system.
3. Hot tap procedure shall be done through a gate or ball valve.

3.16 CLEANING

A. All piping systems shall be thoroughly flushed out with the approved cleaning chemicals to remove pipe dope, slushing compounds, cutting oils, and other loose extraneous materials. This also includes any piping systems which are not listed as requiring water treatment.

B. Develop plan for flushing and cleaning piping. Submit plan for approval prior to completion of piping. Provide all temporary and permanent piping, equipment, materials necessary to complete flushing and cleaning.

C. Prior to flushing, temporarily isolate or bypass dirt sensitive equipment and devices, including the following:

1. Automatic flow control valves
2. All coils
3. Heat pumps
4. Heat Exchangers
5. Flow measuring devices

A full size bypass pipe with shut-off valve shall be installed at each piece of hydronic equipment, as noted above, and at the end of risers serving fan coil units and fin tube radiation.

D. Prior to flushing, install fine mesh construction strainers at inlet to all equipment with connections 2-1/2” and larger. Install fine mesh construction element in permanent strainers. During flushing and cleaning, remove and clean strainers periodically. At completion of final flush, clean permanent strainers, remove construction strainers.

E. Circulate flush water and clean strainers prior to installing cleaning chemicals. Following flushing, install cleaning chemicals and circulate through the entire system for a minimum of one hour, or as directed chemical supplier. Take water sample for owner’s use. Drain system, including all low points. Flush, drain and fill system, circulate for one hour, sample for owner’s use. Drain, flush, fill, circulate and sample until system is free of cleaning chemicals, as indicated by analysis of samples.

F. Clean all water piping and chiller tubes as follows:

1. All new equipment and piping needs to be pre-cleaned to remove the oils of manufacture prior to equipment start-up.
2. The cleaning of new systems is accomplished with an alkaline phosphate cleaner supplied by the water treatment supplier. Coordinate with the Chemical Water Treatment section of this specification.
3. Upon completion of a system cleaning, the system should be flushed until the ortho phosphate is within 1 PPM of City Water. If the flushing occurs over an extended period of time (more than 24 hours) the flush water shall be treated water.
4. The system should then be immediately sterilized and treated. Systems containing copper should boost azole levels to 20 PPM.
5. Systems that contain piping that cannot be isolated for alkaline phosphate cleaning must be cleaned by adding a surfactant for 48 hours to the system. This will help remove the oils of manufacture.

6. New chillers require the following cleaning:
    a. Remove both heads
    b. Punch tubes with reversible tube brushing machine with “Christmas Tree Brushes” and appropriate torque setting for specific tube size. Brushes shall be changed every 5-10 tubes.
    c. Inject alkaline phosphate cleaner into each tube during punching to remove oils of manufacture.
    d. Inspect a minimum of three cleaned tubes with boroscope to confirm removal of all oils. A minimum of one hot, one high flow, and one low flow tube must be inspected.
    e. Tubes shall not be left open to atmosphere for more than one week after exposure to water.
    f. Upon flooding of tubes, azole levels shall be bumped to 20 PPM to insure re-passivation of the copper.

G. After flushing, contractor shall remove all temporary strainers and hang on strainer bodies for inspection.

H. Chemical cleaning and flush water shall be circulated at a minimum velocity of 6 feet per second. Contractors are responsible to supply temporary pumps as required for circulation of water at requisite velocities. Use of system pumps for circulation of cleaning and flush water, where available, is acceptable.

I. The chemical supplier shall verify that all chemicals utilized during cleaning are compatible with the materials in the systems. The chemical supplier shall instruct as to the proper feed rates, shall check that the cleaning solution is actually in each system, shall instruct the contractor as to when to flush the system and shall check each system following flush to insure all cleaning chemicals have been removed from each system.

J. A certificate of cleaning shall be submitted by the cleaning chemical supplier to the Owner’s representative.

3.17 CORROSION PROTECTION

A. Provide dielectric unions at unions between piping of different materials.

B. See water treatment program requirement elsewhere in this specification.

C. All components of system shall be compatible with propylene glycol and water solution.

D. At no time should water be introduced to a system without inhibitor being added.

E. Vapor phase inhibitor shall be used in any case where a system will be drained down prior to turnover.

3.18 PRESSURE GAUGES

A. Pressure/temperature test ports shall be provided on each coil bank, heat exchanger, heat pump, at the base of each riser in the Inn adjacent to the isolation valves, and at all permanent pressure gauge locations. Use extended body style to allow for insulation thickness. Seals shall be appropriate for operating water temperature and pressure as follows.

1. Solar Thermal, Glycol - Nordel Seat
2. Geothermal/Condenser Water - Neoprene Seat

B. Pump assemblies: Use a single gauge with multiple taps to pumped system (strainer inlet, strainer outlet, pump suction and pump discharge) per the detail on the drawings.

C. Allow clearance for removal of gauge.

D. Insure that gauge will be in a readable position.

E. Furnish and install where indicated on the Drawings and where specified herein.

F. All gauges shall be installed so as to be easily readable from the floor. Where conditions are such that gauges on piping would not be readable from the floor, the gauges shall be installed on panelboards.

G. Panel mounted gauges shall be designed for flush mounting with back connections and shall be provided with an engraved nameplate mounted below each gauge to identify its service. The nameplates shall be chrome plated with black filled letters.

H. Differential pressure switches, pressure sensing pipe taps, furnished by temperature control manufacturers shall be installed under this Section.

I. All gauges on water lines shall be fitted with filter type pressure snubbers consisting of 3/8" dia. x 1/8" thick, micro metallic stainless steel filter, as manufactured by Operating and Maintenance Specialties or approved equal. All gauges on steam lines shall be fitted with pigtails.

J. A pressure gauge shall be installed in the suction and discharge of each water pump. A pressure gauge shall be installed in the chilled water and condenser water inlet and outlet of each refrigerating machine. A pressure gauge shall be installed in the inlet and outlet of each heat exchanger and coil. Additional pressure gauges shall be installed where indicated on the Drawings.

K. On devices such as pumps, strainers, coils, etc., where the differential pressure is the desired information, install only one pressure gauge with valved connections to the upstream and downstream pressure taps. Include a P/T test port in addition to the pressure gauge. Provide a second set of isolating valves at the gauge if gauge location is not within reach of tap points.

3.19 THERMOMETERS

A. Furnish and install, where indicated on the Drawings and where specified herein, thermometers as manufactured by American Trerice, Weksler, Weiss or approved equal.

B. All thermometers shall be installed in such a manner as to cause a minimum of restriction to flow in the pipes and so that they can easily be read from the floor.

C. All instrument wells for controls and indicators furnished by the temperature control manufacturer shall be installed under this Section.

D. Where conditions are such that thermometers would not be readable from the floor, remote bulb dial thermometers shall be mounted on panelboards. The thermometers shall be 5 inch dials and shall be vapor actuated. The thermometers shall have separable wells. Panel mounted thermometers shall be provided with an engraved nameplate mounted below each thermometer to identify its service. The nameplate shall be chrome plated with black filled letters.

E. A thermometer shall be installed in the water inlet and outlet of each heat exchanger, heat pump and at the base of each riser in the inn adjacent to the isolation valves. A thermometer shall be installed in the water inlet and outlet of each refrigerator machine. Additional thermometers shall be installed where indicated on the Drawings.

3.20 MACHINERY GUARDS

A. Moving parts of machinery exposed to contact by personnel shall be guarded by barrier to a type which complies with OSHA Code.

B. Exposed moving parts such as belts and couplings shall have not less than 3/4" No. 16 gauge metal guards with all edges rounded an gauge, material and construction shall be in accordance with OSHA standards - paragraphs 7173.3, 7173.5 and 7174.1. Guards shall have 1-1/4" x 1-1/4" x 1/8" angle iron frame properly supported.

C. All machinery guards covering the ends of motor or equipment shafts shall have openings for the insertion of a tachometer. Machinery guards shall be painted with two coast of machinery gray enamel.

3.21 EXPANSION TANKS

A. Expansion tanks shall be welded, and of the size as indicated on the Drawings. Tanks shall be galvanized after fabrication. Tanks shall be steel with dished heads and equipped with connections for fill, drain and system connections. Water column and connections shall be furnished. Tanks shall be constructed in accordance with ASME Code for Unfired Pressure Vessels and so stamped.

B. Tanks shall be provided with gauge glasses for full height, and for closed tanks provide combination air charger and tank drainer. Gauge glasses shall have protective shield.

C. Furnish and install as shown on the Drawings, EX-TROL Pressurized Diaphragm Type Expansion Tanks as manufactured by AMTROL INC. It shall be air precharged to the initial fill pressure of the system. It shall be suitable for a maximum working pressure in excess of anticipated system pressure at maximum operating temperature and shall be furnished with ASME stamp and certification papers. It shall have a sealed-in elastomer diaphragm suitable for an operating temperature of 240°F. Horizontal tanks to be furnished with saddles for horizontal installation where applicable.

3.22 EXPANSION JOINTS, LOOPS, ANCHORS AND GUIDES

A. Provisions for expansion in piping mains, branches, and risers shall be made by the installation of offsets, expansion loops, or compensators as indicated on the Drawings or as required by these specifications. Every 100'-0" horizontal steam and hot water piping shall have expansion loop and anchors. Minimum loop shall be 8'-0" by 6'-0" if not indicated on the Drawings.

B. All piping with loops or compensators shall be anchored so as to throw all expansion toward the loops or compensators.

C. Guides shall be installed on both sides of each expansion loop and compensator. Guides shall be Flexonics pipe alignment guides or approved equal. Anchors and guides shall be secured to beams, columns or concrete slabs.

D. Pipe hangers and rollers are not considered guides.

E. Provide 12" long guides for each expansion joint. Guides shall be located 3'-0" on each side of the expansion joints.

F. For copper piping: Furnish and install as shown on plans, or where necessary to absorb max. 1-3/4" expansion and max. 1/4" contraction between two anchor points in copper lines, up to and including 2-1/2", Flexonics Model HB Expansion Compensators having two-ply phosphor bronze bellows and brass shrouds and end fittings, as manufactured by Flexonics Division of Calumet and Heela, Inc., Bartlett, Illinois. All internal parts shall be of non-ferrous metals. Service pressure shall be external to the bellows. Compensators shall have internal guide extending the full length of the bellows travel. Compensators shall have internal positive anti-torque devices to prevent twist or torque on installation and shall have properly located positioning clip to insure installation of correct end-to-end dimension to allow full rated traverse. Compensator shall be for max. 125 psig. working pressure. Test pressure shall not exceed 175 psig.

G. For steel piping: Furnish and install as shown on plans, or where necessary to absorb max. 1-3/4" expansion and max. 1/4" contraction between two anchor points in iron and steel pipe lines up to and including 2-1/2", Flexonics Model II Expansion Compensators having two-ply stainless steel bellows and carbon steel shrouds and end fittings, as manufactured by Flexonics Division of Calumet & Heela, Inc., Bartlett, Illinois. Service pressure shall be external to the bellows. Compensators shall have properly located positioning clip to insure installation at correct end-to-end dimension to allow full rated traverse. Compensator shall be for Max. 150 psig. working pressure. Test pressure shall not exceed 200 psig.

H. Expansion joints in 3" and above piping shall by hydraulically formed bellows type with internal sleeves and external covers for insulation. Expansion joints, except where otherwise noted, shall be of the self-equalizing type having fully-contoured, cast iron equalizing rings.

Provide non-equalizing type expansion joints with internal sleeves on low pressure service (up to 15 psig including test pressure) such as diesel engine exhaust, or flexible cooling tower connections.

I. Manufacturer shall note on all submittal forms the resultant anchor loads due to pressure thrust and compressive forces at design conditions. Expansion joints shall be as manufactured by ADSCO, Zallea, Flexonic, or approved equal.

3.23 AUTOMATIC FLOW-CONTROL VALVES

A. The Contractor shall provide and install for each heat pump and fan coil unit, one "Autoflow" model FVT or Griswold compact pressure compensating flow control valves in one piece configuration consisting of ground joint union and flow control valve and Petes plugs. Petes plugs shall be provided on both sides of condenser flow heat pumps only.

B. All valves are to be factory set to control the flow rate within 4% of the selected rating over an operating pressure differential of at least ten times the minimum required for full flow conditions.

C. The valves shall be all metal with threaded or seat connections. Metallurgy shall be all brass and stainless steel.

D. Performance certification of valves by an independent laboratory shall be furnished.

E. All valves shall have unions to allow field-exchange of internal components without removing the valve body from the pipeline.

F. All valves shall be permanently marked to show direction of flow and flow rates.

3.24 AIR SEPARATORS

A. Furnish and install the air separators for water system where indicated on the Drawings. The separators shall be Rolairtrol, as manufactured by Bell and Gossett or equal as approved by the Architect.

B. The units shall be of ASME construction and shall be stamped 125 psig W.P.

C. The units shall be furnished without integral strainers.

D. The units shall have a flow capacity greater than or equal to the total system design flow rate.

E. The units shall be installed in strict accordance with the manufacturer's recommendations. The units shall be supported on 2" pipe legs and shall be provided with a 3/4" drain gate or ball valve with hose end and cap.

3.25 STRAINERS FOR WATER SYSTEM

A. Furnish and install a full size Y-pattern strainer on the inlet of each control valve at each water pump and where indicated on the Drawings.

B. An approved blow-out connection with gate valve shall be made to each strainer. The valves shall be located not higher than 8 feet above the floors. All drain connections shall be piped to floor drains.

3.26 REDUCING AND SAFETY VALVES FOR WATER SYSTEM

A. Furnish and install pressure reducing and safety valves for makeup water systems and where indicated on the drawings.

B. The reducing valve shall be Model 7 pressure reducing valve with field adjustable setting as manufactured by Bell & Gossett or equal as approved by the Architect.

C. The safety valves shall be of size and capacity as indicated on the Drawings. The valves shall be made by Bell and Gossett or approved equal and shall have 150 pound raised face flange on the inlet and discharge for all sizes 2-1/2" and above 2" and below shall be screwed.

D. The safety valve shall be steel valves with stainless steel trim. The bonnet shall be enclosed and equipped with a packed lifting lever. The spring shall be carbon steel rated for 450˚F.

E. The vertical discharge line from the safety valves shall be installed as close to the safety valves as possible and piped to drain.

3.27 FLOW MEASURING DEVICES

A. Provide complete Venturi flow measuring system as manufactured by Barco Division, Aeroquip Corp., or approved equal.

B. Upstream pipe diameters of straight pipe shall be five (5) minimum and downstream pipe diameters shall be two (2) minimum as recommended by manufacturer.

C. For location of Venturi flow stations refer to the Drawings.

3.28 PIPE SLEEVES

A. Install pipe sleeves where piping passes through walls, floors, ceilings, roofs and structural members, except soil pipe penetrations through concrete slab on grade.

B. Where possible pour sleeve in place or grout.

C. Provide sleeves of adequate size, accurately centered on pipe runs, so that piping and insulation (if any) will have free movement in the sleeve in non-fire rated penetrations.

D. In fire rated penetrations, size sleeves such that the resulting annular space is in accordance with the application requirements of the fire stopping system. All above grade floor penetrations shall be considered to be fire-rated.

E. Install length of sleeve equal to thickness of construction penetrated, except extend floor sleeves 0.25” above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 0.75” above floor finish.

F. Provide temporary support of sleeves during placement of concrete and other work around sleeves.

G. Provide temporary closure to prevent concrete and other materials from entering pipe sleeves.

H. Except as otherwise indicated, install steel pipe sleeves.

I. At interior partitions and ceiling, install sheet metal sleeves.

J. At exterior penetrations below grade, install iron pipe sleeves.

K. Seal exterior sleeve penetrations at grade weather tight.

L. Caulking:

1. Where water seal or sound seal, but not fire seal, is needed, (foundation walls, slab on grade): fiberglass backing and heavy bead of silicone caulking compound.
2. Where sleeve pierces a fire separation: Fire stop material in accordance with manufacturer’s directions and UL listing.

M. Install escutcheon plates at pipe sleeves where piping is exposed to view in occupied spaces of the building, on the exterior, and elsewhere as indicated.

N. Compensators: Install where shown or where required because piping arrangement does not provide sufficient flexibility.

1. Protect compensators from over-travel and over-stress during remaining installation and testing.

O. Flexible Connectors: Install at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

P. Guides: Install where shown and where required in accordance with expansion compensators published requirements. As a minimum, install one guide within four pipe diameters of compensator, and one guide 14 pipe diameters from first guide.

3.29 TEST

A. Hydronic piping systems other than ground source heat pump loop shall be hydrostatically tested at one and one half times the system design operating pressure unless a higher pressure is required elsewhere, but not less than 100 psi. The duration of each test shall be not less than 4 hours.

B. See additional requirements elsewhere in this specification.

END OF SECTION

SECTION 23 21 23

HVAC PUMPS

PART 1 - GENERAL

1.1 MOTOR HORSEPOWER

A. Do not increase or decrease motor horsepower from that specified without written approval from Architect/Engineer. See Section 23 05 01.

B. Select pumps so that for single pump application at a minimum, brake horsepower does not exceed motor horsepower at rating point, and does not exceed motor horsepower plus service factor on impeller curve at 125% rated flow. For parallel pump application motor horsepower shall be selected such that pump can operate at any point on the pump curve without overloading.

C. Pumps shall be selected such that motor can operate at 60 Hz speed without overloading at any point on the pump curve.

1.2 REFERENCES

A. HI - Hydraulic Institute.
B. ANSI - American National Standards Institute.
C. OSHA - Occupational Safety & Health Administration.
D. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers.
E. NEMA - National Electrical Manufacturers Association.
F. UL - Underwriters Laboratories.
G. ETL - Electrical Testing Laboratories.
H. CSA - Canadian Standards Association.
I. NEC - National Electric Codes.
J. ISO - International Standards Organization.
K. IEC - International Electrotechnical Commission.
L. ASME – American Society of Mechanical Engineers.

1.3 PARALLEL PUMP SELECTION

A. Select pumps for parallel pump application such that a single pump can operate and not exceed the end operating point of the pump curve.

1.4 SUBMITTALS

A. Submit each item in this article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Submit manufacturer’s installation instructions under provisions of General Conditions and Division 1.

1. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.
2. Under provisions of commissioning documentation, testing of pumps, as well as training of owner’s operation and maintenance personnel may be required in cooperation with the commissioning consultant.

C. Manufacturers Product Data: Submit manufacturer’s product data on pumps.

1. Include pump curve and mark rating point. Also include single pump operating point for a parallel pump application.

2. Show maximum allowable operating temperature and pressure.
3. Power and control wiring diagram
4. System profile analysis including pump curves, system curve, and variable speed pump curves
5. Note in red any deviations from specified construction.
6. Show impeller diameter indicate maximum impeller diameter for pump volute provided, and indicate if impeller is machined down.

D. Hanging and support requirements should follow the recommendations in the manufacturer's installation instructions

E. A detailed weighted average pump efficiency-Part Load Efficiency Value (PLEV) - Pump Rating Report shall be submitted for each pump. Pump PLEV shall be based on the standard load profile developed in AHRI 550/590-1998 also known as IPLV or Integrated Part Load Value. The pump PLEV Rating shall be based points A: 100%, B: 75%, C: 50% and D: 25% with each Pump Efficiency ratings shown with flow matched to load percentage and Specified Control Head.

F. Specified Control Head shall be 30% TDH or calculated minimum control head specified within the equipment schedule

G. All pumps controlled by variable frequency drives shall have shaft grounding kits.

H. Pump PLEV shall be expressed with load weighting Pump
PLEV = 1/(0.01/A+0.42/B+0.45/C+0.12/D) where

A= Pump Efficiency at 100%
B= Pump Efficiency at 75%
C= Pump Efficiency at 50%
D= Pump Efficiency at 25%

Actual job specific load profile weighting may be substituted for standard IPLV weighting

I. Submittals that are "rejected" as being "non-compliant" will be re-reviewed once with all time for subsequent reviews back charged to the contractor in accordance with the engineer's current prevailing rate schedule. If a rate schedule for additional services is included, as part of the contract with the owner that rate schedule shall be used in lieu of the "current prevailing" rate schedule.

1.5 QUALITY ASSURANCE

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

B. Ensure pump operation, at specified system fluid temperatures without vapor binding and cavitation, is non-overloading in parallel or individual operation, and operates to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified.

D. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years experience.

E. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in such a matter as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials damaged by the elements should be packaged in such a matter that they could withstand short-term exposure to the elements during transportation.

B. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

C. Use all means necessary to protect equipment before, during, and after installation.

D. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect Engineer.

1.7 WARRANTY:

A. Provide a minimum One (1) year warranty on materials and installation under provision of Section 01 78 36

PART 2 - PRODUCTS

2.1 IN-LINE CIRCULATOR FOR HEATING (Small - Horizontal Motor)

A. Manufacturers:

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Taco
   b. Armstrong
   c. Aurora

B. Design Conditions:

1. Pressure: 125 psig
2. Temperature: 225ºF

C. Construction:

1. Motor Mount: Resilient.
2. Bearings: Sleeve, bronze, oil lubricated.
3. Casing: Cast iron.
4. Impeller: Steel, cadmium plated, cast iron, or bronze.
5. Shaft: Steel with copper sleeve or stainless steel.
6. Seal: Mechanical.
7. Coupler: Spring or flexible sleeve.
8. Motor: Open, Drip Proof

D. The pumps shall be of the horizontal, oil-lubricated type, specifically designed and guaranteed for quiet operation. Suitable for 125# working pressure.

E. The pumps shall have a ground and polished steel shaft with a hardened integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps are to be equipped with a watertight seal to prevent leakage. The motor shall be non-overloading at any point on pump curve. Impellers shall be of bronze construction.

2.2 SPLIT COUPLED VERTICAL IN-LINE PUMPS WITH INTEGRATED CONTROLS

A. Manufacturers

1. Design Basis: Bell & Gossett
2. Other Acceptable Manufacturers:
   a. Armstrong
   b. Peerless
   c. Grundfos

B. Supply and install pumps as shown and scheduled. The pumps shall be single stage, single or double suction type, vertical inline design. The seal shall be serviceable without disturbing the motor or the piping connections. The capacities and characteristics shall be as outlined in the plans and specifications. The complete pump unit shall be labeled with ETL listing certification that the product conforms to UL Std 778 and is certified to CSA Std C22.2 No.108.

C. Components

1. The pumps shall be a split-coupled, inline for vertical installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 250° F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.

2. The pumps shall have a 416 stainless steel shaft that is guided by a carbon graphite lower throttle bushing.

3. Pump shall be equipped with a Unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal-to-metal drive system to reduce torsional stress on the bellows. The bellows will be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face.

4. Pump shaft shall connect to a stainless-steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.

5. The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.

6. The combination motor bracket and volute coverplate shall be a one-piece unit to ensure concentric alignment of the motor to the pump casing. A carbon steel coupler guard conforming to both ANSI B15.1-2000 and OSHA 1910.219 standards shall be mounted on the motor bracket for safety.

7. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.

8. Motors shall be NEMA Premium efficient and shall be the size, voltage, and enclosure called for on the plans. Motors shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.

9. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

10. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.

11. Pump manufacturer shall be ISO-9001 certified.

12. Each pump shall be factory tested and name-plated before shipment.

13. As an option, the pump may include an internal stainless-steel casing wear rings.

14. Where noted on schedule pumping equipment may require one or all of the following optional tests: Certified Lab tests (unwitnessed), Hydraulic Institute Level B tests, or Witnessed Tests.

D. Accessories

1. Provide one mechanical seal for each model type of primary pump.

2. All pumps controlled by variable frequency drives shall have shaft grounding kits.

3. Sediment Separator shall be furnished for installation on the flushing line between the pump discharge flange and the seal area. The sediment separator is installed to increase the overall life expectancy of the seal on inherently dirty systems. The separator shall remove dissolved solids from the flushing medium before the fluid enters the seal area where it can damage and shorten the life of the seal.

E. Integrated VFD with Sensorless Pump Control

1. Integrated Pump Controller shall be factory mounted, wired, with a mains disconnect switch and menu-driven graphical interface.

2. Integrated Pump Controller shall provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.

3. Integrated Pump Controller shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.

4. Integrated Pump Controller shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.

5. System pressure to be maintained as scheduled. Pressure setpoint shall be able to be field adjusted.

6. Integrated Pump Controller shall support direct communication with the building management system (BMS) with built-in support for the following protocols: (Modbus RTU, BACnet™ MS/TP, Metasys N2). Mechanical contractor to coordinate control protocol with control contractor.

7. Integrated Pump Controller shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.

8. Integrated Pump Controller shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.

9. Integrated Pump Controller shall provide a temperature controlled Fan for cooling of the heat sink in the back panel.

10. Integrated Pump Controller shall be rated to operate in ambient working conditions of [14°F to +113°F], up to 3300 feet above sea level.

11. Integrated Pump Controller shall provide 2 Analog inputs (current or voltage) and 1 current output.

12. Integrated Pump Controller shall provide 6 programmable Digital inputs with 2 configurable as outputs.

13. Integrated Pump Controller shall support 2 programmable pulse inputs

14. Integrated Pump Controller shall provide 2 programmable relay outputs

15. Integrated Pump Controller shall provide 1 RS485 communication port

16. Integrated Pump Controller system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.

17. Integrated Pump Controller Sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.

18. Integrated Pump Controller shall support a minimum head of 40% of design duty head.

19. Integrated Pump Controller shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

20. Integrated Pump Controller integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.

F. Integrated Pump Controller integrated control software shall be capable of maintaining flow rate data.

2.3 CONDENSATE PUMP

A. Condensate pump shall be heavy duty vertical type pump with rust resistant polymer condensate collecting tank. Constructed of materials providing maximum resistance to corrosion including high impact polymer pump base, stainless steel shell and epoxy coated metal tank cover and switch housing.

B. Pump shall discharge 1-1/4 quarts of water per cycle.

C. Pump shall automatically start when water level reaches approximately 3-3/8" from bottom of tank, and stop pumping when level drops to 2".

D. Unit shall include fan cooled motor, integral sump tank, control float, and safety float/switch which shall be wired to shut off low voltage thermostat controlling air conditioner if malfunction occurs.

E. Provide condensate pump and electrical connection for each air conditioning unit or air handler not specifically shown to be piped by gravity to a floor drain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install equipment in accordance with manufacturer’s instructions.
2. Install pumps to allow complete removal without dismantling connecting piping.
3. Provide air cock and drain connection on pump casing.
4. Decrease from line size with long radius reducing elbows or concentric reducers, or suction diffusers.
5. Support piping adjacent to pump so that no weight is carried on pump casings.

6. Comply with manufacturers recommendations for support of inline pumps. Provide support for motors when mounted horizontally. Verify Manufacturer's allowable motor position and install accordingly.
7. Provide supports under elbows on pump suction and discharge line.
8. Provide pressure gauge with piping and gauge cock to measure pressure of strainer inlet, pump suction, and pump discharge.
9. Manufacturer's representative shall verify proper pump operation.
10. Provide gate valves to allow isolation of pump from system.
11. Provide check valve as pump discharge.

B. Motor Mount – Inline Pumps:

1. Verify motor position (vertical or horizontal) with manufacturer's installation instructions.
2. Provide proper pump support in accordance with manufacturer's installation instructions. Do not support pump from equipment.
3. Provide adequate clearance around pump for motor and shaft removal.

C. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

D. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller.

E. Provide temperature and pressure gauges where and as detailed or directed.

F. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

G. Lubrication: After completion of the system and before start-up, lubricate the pumps.

H. Impeller Trim: Remove impeller and machine down if more than 25% of the total pump head must be throttled by the pump discharge valve.

I. For inline pumps with motors 7.5 HP and larger, provide a suitable lifting point (eye bolt, strut channel) directly over the motor to aid in removal of the rotating element.

J. Pipe drip pan base to floor drain.

K. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

L. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

M. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

N. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

O. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.

P. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

Q. Fully grout base mounted pumps to housekeeping pads or inertia base per manufacturer's recommendations.

R. All pump casings shall be hydrostatically tested at 1-1/2" times design working pressure. The pump manufacturer shall be responsible for his service department aligning in the field prior to start-up of all flexibly coupled units. Alignment shall be with dial indicator with accuracy of plus or minus .002 inches. The pump manufacturer must submit a written report certifying that the alignment work had been performed by his personnel and that the pumps are ready for operation.

S. A factory authorized service representative shall be engaged to train the Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Training shall include proper alignment techniques and maintenance requirements.

END OF SECTION

SECTION 23 22 14 - GEOTHERMAL HEATPUMP PIPING AND VERTICAL HEAT EXCHANGERS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Ground-coupled heat exchanger and connections to building piping system.

1.2 REFERENCE STANDARDS

A. APHA (EWWW) - Standard Methods for the Examination of Water and Wastewater; 2017 (23rd Edition).
B. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.
C. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products; 2013, with Editorial Revision (2014).
D. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2015.
E. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing; 2016.
F. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material; 2014.
G. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter; 2013 (Reapproved 2019).
H. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing; 2016a.
I. IGSHPA (GROUT) - Grouting Procedures for GHP Systems; International Ground Source Heat Pump Association; 1991.
J. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe; 2017.
K. ANSI/CSA/IGSHPA C448 Series-16 - Design and installation of ground source heat pump systems for commercial and residential buildings

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section. Require attendance by all installers involved with site work and HVAC work.

1.4 SUBMITTALS

A. Product Data, Polyethylene Piping: Provide manufacturer's data for piping and pipe fittings, showing compliance with specified requirements.
   1. Provide manufacturer's recommendations for fusion jointing.
   2. Include certification of long term hydrostatic basis, or test reports.
B. Product Data, Heat Exchange Fluid: Provide data showing compliance with specified requirements.
   1. Provide manufacturer's Material Data Safety Sheets.
   2. Provide results of biodegradability studies conducted in accordance with APHA (EWWW):
      a. Statement of ecological behavior.
      b. Total oxygen demand, in pounds (kg) of oxygen per pound (kg) of fluid.
      c. Percent of fluid degraded in five days.
C. Product Data, Grout and Slurry: Provide information including thermal conductivity, density, mixture, etc of proposed materials.
D. Product Data, Interior Valves and fittings: Provide information on valves and fittings to be used inside the building. Refer to other Division 23 technical specifications for interior piping, valves, fitting, gauges and insulation requirements.
E. Shop Drawings: Show complete piping layout, depths of excavation, final depths of piping, backfill placement, point of entrance to building, test point locations, and fittings used for all joints and connections.
F. Test Reports, Piping: Indicate test method and results of hydrostatic pressure tests.
G. Record Documents: Record actual locations of all underground piping installed relative to Owner's permanent structure on same property.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of documented experience and accredited by IGSHPA.
B. Well driller qualifications: Geothermal well drillers shall have a minimum of five years' experience in the installation of geothermal well field installation and shall be licensed in the jurisdiction where the project is located.
C. Heat Fusion Technician Certification: IGSHPA training and certification, certified within three years from the date of project commencement.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping and fittings to project site in shipping containers with labeling in place.
   1. Verify that labels on piping indicate manufacturer's name, pipe or tube size, and PE cell classification.
   2. Verify that piping complies with specifications and is undamaged.
B. Deliver chemicals for heat exchange fluid to project site in unopened shipping containers with labeling in place; comply with local and state regulations.
C. Protect from weather, humidity and temperature variations, dirt and dust, and other environmental contaminants.
D. Store piping capped or plugged until time of installation.

1.7 PROJECT CONDITIONS

A. Existing utilities: do not interrupt utilities serving facilities occupied by the owner or others unless permitted by the affected parties and then only after arranging to provide temporary utility services according to the requirements indicated:
   1. Notify the owner not less than two days in advance of proposed utility interruptions.
   2. Well drilling water: contractor shall be responsible for providing water for the drilling purpose.
   3. Well driller shall be responsible for removing all drilling mud, fluid and waste material generated by drilling operations.
   4. Reasonable care shall be taken to avoid damage to tree roots and canopies, especially those over 6" in diameter.

PART 2 - PRODUCTS

2.1 WELL CASING

A. Well casings: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

2.2 HEAT EXCHANGER

A. Install the ground-coupled heat exchanger as designed and laid out on the Contract Documents.
B. Heat Exchanger Configuration: Closed system; polyethylene piping in vertical boreholes located as indicated on drawings.
   1. Pipe Type: SDR11 High density polyethylene.
   2. Pipe Diameter: 1-1/4 inch.
   3. Shank Spacing: 1/8 inch.
   4. Borehole Depth: 500 feet.
   5. Borehole Diameter: 6 inches .
   6. Borehole Spacing: 25 feet, minimum.
   7. Total Number of Boreholes: 56 (55 new bore holes and 1 existing bore hole from site conductivity test).

2.3 MATERIALS

A. Pipe: High density polyethylene pipe, type PE4710, ASTM D 3035, DR 11.
   1. Comply with ASTM D 3035 with minimum working pressure rating of 200 psi at 73 degrees F.
   2. ASTM D3350 cell classification PE445574C
   3. Long Term Hydrostatic Design Basis: 1600 psi at 73 degrees F, when tested in accordance with ASTM D2837; appropriate listing in current edition of PPI TR-4 will constitute evidence of compliance with this requirement; otherwise, submit independent test results.

4. Joints and Fittings: Polyethylene of same type as pipe, of sizes and types suitable for the pipe being used; use only heat fusion or stab-type mechanical fittings that are quality controlled to provide a leak-free union between piping ends that is stronger than the piping itself. Do not use other barbed fittings or hose clamps.
   a. Electrofusion Type Fittings: Comply with ASTM F1055.
   b. Butt Fusion Fittings, 1-1/2" pipe and above: Comply with ASTM D3261.
   c. Socket Type Fittings, up to 1-1/4" pipe: Comply with ASTM D2683.
   d. Where threaded fittings must be used for connection to equipment or dissimilar piping, use fittings and thread sealant compatible and effective with antifreeze used.
   e. Provide pre manufactured, molded U-bend at bottom of vertical bore designed for geothermal application.

B. Heat Exchange Fluid: Water and antifreeze solution, 25 percent propylene glycol by weight.

C. Detectable Underground Tape: Magnetic detectable conductor in 2 inch (50 mm) wide rot-resistant plastic tape or mesh, brightly colored, imprinted with "Water Line" in large letters.

D. Grout for Vertical Boreholes: Thermally-enhanced bentonite/high-grade silica sand grouting compound with a minimum thermal conductivity value of 1.2 btu/hr-ft-°f as determined when tested in accordance to ASTM D 5334. Grout mixture shall have a maximum permeability rate of less than 1x10^-7/ cm/s as determined by ASTM D 5084. Grout mixture shall be geo-pro TGlite 1.2 or approved equal with a maximum density of 10.5 lb/gal.

E. Interior piping, valves and fittings: Refer to Division 23 specification sections for interior piping, valve, fittings, gauges and accessories.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate in accordance with requirements of authorities having jurisdiction.

B. Remove rock as required to achieve specified depths.

C. Vertical Boreholes: Drill to depths as detailed on contract drawings.
   1. Provide continuous steel casing on upper portion of borehole until bedrock is reached. Casing is not required within bedrock.
   2. Set casings within bores plumb and true to line.
   3. Piping: Assemble heat exchanger piping and test before grouting and covering.

D. Trenches: Excavate trenches for piping to lines and grades shown on drawings.
   1. Excavate to accommodate grade changes.
   2. Maintain trenches free of debris, material, and obstructions that may damage pipe.
   3. Piping: Assemble heat exchanger piping and test before backfilling.

3.2 POLYETHYLENE PIPING

A. Join piping and fittings using heat fusion or electrofusion; do not use solvents, adhesives, or mechanical fittings.

B. Provide flanges or unions to connect heat exchanger piping to equipment or piping of different type; locate all transitions between piping of different types inside the building or otherwise accessible (i.e. above grade).

C. Keep dirt and debris out of pipe assemblies; cap or plug open ends until connected to adjacent piping.

D. Do not bend piping to shorter radius than recommended by pipe manufacturer; do not kink piping; use elbow or other fittings for sharp bends.

E. Partially backfill radius bends in narrow trenches by hand to ensure that piping is properly supported and to prevent kinking.

F. The loop tubes and the tremie pipe shall be installed into the vertical borehole heat exchanger the same day the vertical borehole heat exchanger is constructed.

3.3 GROUTING

A. After installation and testing of piping within bore, place grout continuously, from bottom to top surface to ensure filling of annular space in one operation.

B. The loop tube shall be pressurized with water during the entire grouting process to protect it against shear forces caused by the grout. The hydrostatic pressure level shall be adapted with grout density and borehole depth.

C. Grout shall be placed in the borehole by pressure pumping through a tremie pipe after enough water or other drilling fluid has been circulated in the annular space to clear obstructions;
D. Tremie grouting of the entire vertical borehole using the grout material specified and shall be completed within a timeframe to ensure total loop well grouting and ensure aquifer protection;
E. The tremie pipe shall be lowered to the bottom of the borehole, raised slowly as the grout is introduced and should be continuously submerged in the grout.
F. Once the grout has settled for a minimum of 48 h, the ground source heat pump system contractor shall ensure that the vertical borehole heat exchanger(s) are filled with grout to the top of the vertical borehole heat exchanger; and regular verification of the grout mixture shall be carried out as follows:
    1. Verification of grout mix ratio, mixing procedures, grouting, and topping off of vertical borehole heat exchanger with grout shall be undertaken on an ongoing basis during ground source heat pump installation
    2. Density and water content, or alternatively, grout thermal conductivity of the samples, shall be measured to ensure the grout mixture is in accordance with the specified grout recipe.

3.4 TESTING

A. At several stages of the installation the pipe installed shall be pressure tested with result documented and turned over to owner and engineering for approval. If deficiencies are found, the point of leakage shall be found, repaired and test repeated. This procedure shall be followed until the piping systems have been proved absolutely tight.
B. Caution shall be exercised to prevent direct sunlight or significant air temperature changes from affecting the results.
C. The use of any chemicals, any "Stop-Leak" compounds, any mastic or any other temporary means shall not be used for repairing leaks during or subsequent to these tests.
D. Pressure tests for polyethylene pipes shall be conducted in accordance with ASTM F2164, which provides information on apparatus, safety, pre-test preparation, and procedures for conducting field tests of PE pressure piping systems by filling them with a liquid and applying pressure to determine if leaks exist in the system.
E. The duration of the pressure test shall be no less than 1 h after the stabilization of pressure. If no visual leakage is observed and pressure during the test phase remains steady (within 5% of the test phase pressure), a passing test is indicated.
F. Loops must pass the test at the following milestone:
    1. Prior to insertion of the vertical piping into the bore holes, the contractor shall assemble the "U-Bend" and piping, cap both ends, and pressure test the piping to a pressure of 100 psig. Reduce pressure to 0 psig before lowering into borehole.
    2. After each runout has been assembled, including connection to the grouted vertical borehole heat exchangers and before backfilling, test piping to a pressure of 50 psig.
    3. After the complete ground-heat exchanger has been installed, flushed, and purged of air and debris and before the ground heat exchanger has been filled with glycol connected to the building system, test piping to a pressure of 50 psig.
G. Contractor is responsible to provide evidence of and certification of pressure testing, and acceptance of all work performed by signature of contract inspector.
H. After the conclusion of the ground heat exchanger pressure test, the ground heat exchanger shall be left filled with ultimate fluid to be used in the system and be maintained under pressure until final connection to the building system.

3.5 FLUSHING, PURGING AND CHARGING

A. All geothermal piping systems shall be thoroughly cleaned before placing in operation to rid the system of dirt, piping compound, mill scale, oil, and any and all other clean and balance the piping installed under his contract.
B. Extreme care shall be exercised during construction to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project to have the open ends capped and equipment to have all openings fully protected. Before erection, each piece of pipe, fittings, or valve to be visually examined and all dirt removed.
C. The ground heat exchanger shall be flushed with potable water by means of a flushing unit equipped with a tank for air separation, suitable filters, a water flow meter, pressure gauges and valves to reverse the flow. All flushing flow shall pass through a suitable filter until the water is observed to be clear and clean.

D. Each supply and return circuit shall be flushed and purged in the forward and reverse directions with water at a minimum velocity of 2 ft/s through each piping section. A calibrated flow meter shall be used to verify the flow velocity.
E. To verify the effectiveness of a purge, the valve leaving the borehole field shall be closed while monitoring the make-up water level in the purge tank. If the level does not go down, there is little air in the system. The system should be pressurized to 50psig after purging is complete. When the borehole field is connected to the system the residual pressure will ensure that the system is intact and that no air has been introduced into the system.
F. Prior to specifying water treatment and selecting an anti-freeze solution for the system, a sample of the local water shall be analyzed to identify existing local water chemistry. Where applicable and permitted by the authority having jurisdiction, the heat transfer fluid may contain chemical inhibitors to protect the biological and chemical integrity of the solution to prevent corrosion of system pipes.
G. Charge system with specified glycol mixture after all testing, flushing and purging has occurred and been accepted by the owner.
F. Install system label at purging valves, indicating:
    1. Heat exchange fluid, including antifreeze type and concentration.
    2. Service date.
    3. Company name.
    4. Company phone number and responsible person.

3.6 BACKFILLING

A. Install in compliance with local authorities having jurisdiction.
B. Vertical Boreholes: Backfill after pipe installation in accordance with IGSHPA (GROUT) - IGSHPA Grouting Procedures for GHP Systems.
C. Trenches:
    1. Provide minimum 5 foot cover over piping.
    2. Backfill trenches after pipe has been installed and tested, using fill free of rocks and other debris.
    3. Install detectable tape continuously 6 inches (150 mm) above top of all buried pipe.
    4. Backfill and compact using the procedures specified.
    5. Backfill to original grades with sufficient overfill to allow for settlement.
D. Protect piping from displacement.

3.7 CLEANING

A. Leave adjacent paved areas broom clean.
B. Clear debris, including excess backfill and excavated dirt and rock, from heat exchanger area.

3.8 PROTECTION

A. Protect area during excavation from excess runoff and erosion. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from project site and restore site to finished grade.
B. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination.
C. Protect pipe protrusions from damage until connections to building systems are installed.

3.9 IDENTIFICATION

A. Install continuous underground detectable warning tape for underground piping. Locate below finished grade, directly over piping.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Installer: A firm with at least five years of successful installation experience on projects with refrigerant piping similar to that required for this project.

1.2 REGULATORY/REQUIREMENTS

A. Comply with applicable requirements of the Clean Air Act and City and local Regulations concerning handling of refrigerants.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. Type ACR copper tube with wrought copper fittings, brazed, 300#, Silver Solder.

1. The silver solder on all connection in the suction, discharge, and liquid lines shall be cadmium-free with a minimum of 45% silver. When soldering components such as vibration eliminators, ball valves, etc., the manufacturer's instruction for brazing or soldering must be followed (wrapping device in a wet cloth, etc.). At all times during brazing or soldering, nitrogen purge shall be used.

B. End Caps:

1. Provide factory applied plastic end caps on each length of pipe and tube.
2. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

C. All joints shall be in accessible locations. All 90° fittings shall be of the long radius type. Close ruff or short turn ells will not be permitted on any installation. Quick connect couplings are not permitted in any systems.

2.2 SHUT-OFF VALVES

A. Manufacturers:

1. Design Basis: Henry
2. Other Acceptable Manufacturers:
   a. Mueller
   b. Superior
   c. Imperial

B. Size 7/8 Inch and Smaller:

1. Model: Series 600.
2. Type: Pack-less diaphragm.
3. Material: Bronze.
4. Flow: Non-directional.

5. Servicing: Diaphragm changeable under line pressure.

C. Size 1-1/8 Inch and Larger:

1. Model: Series 200.
2. Type: Wing cap, back seating.
3. Material: Bronze.

2.3 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

1. Design Basis: Mason
2. Other Acceptable Manufacturers:
   a. Metraflex
   b. Flexonics

B. Braided bronze with copper tube ends, compatible with refrigerant type for system

C. Flexible connector shall be line size or connection size, whichever is larger.

2.4 REFRIGERATION SPECIALTIES

A. Filter Drier:

1. Conform to ARI Standard 710.
2. Sizes ½" and larger - interchangeable core, full flow.
3. Sizes smaller than ½" - sealed type.
4. Minimum burst pressure - 1500 psig.
5. Refrigerant Filter-Dryer: Refrigerant filter-dryers shall be replaceable core "Catch All" type, as manufactured by Sporlan Valve Company.

B. Sight Glass:

1. Double port moisture indicating, reversible color indicator.
2. Removable sight glass and moisture indicating element.
3. Furnish with a protective cover.

C. Expansion Valve:

1. Thermostatic type, diaphragm or bellows operated.
2. External superheat adjustment factory set for 10ºF superheat (adjustable).
3. Compatible with refrigerant type for the project.
4. Pressure rated per project requirements.
5. Power elements and valve size shall be as recommended by the manufacturer, for the service intended.
6. Thermal expansion valves shall be Type "MVE-G", as manufactured by Sporlan Valve Company, or approved equal, with external equalizer and remote bulb with refrigerant 22 charge.

D. Solenoid Valve:

1. Provide solenoid valve for systems 25 tons and larger.
2. Compatible with refrigerant type for the project.
3. Valve shall fail in closed position (power open).
4. Valves to have stainless steel diaphragm-welded and lead-proof construction, replaceable thermostatic element and tight seating. Valve shall be as manufactured by Sporlan Valve Company or approved equal.

E. Moisture and Liquid Indicator: Provide combination liquid and moisture indicators type "See All", as manufactured by Sporlan Valve Company.

F. Refrigerant Strainers: Provide Refrigerant Strainers. Strainers shall be as manufactured by Henry Valve Company, Type 895.

1. Acceptable Manufacturers:

a. Alco
b. Sporlen

PART 3 - EXECUTION

3.1 INSTALLATION

A. Run piping level or plumb, except slope gas piping to compressor with a minimum number of elbows.

B. Provide oil traps at bottom of suction risers. Size risers for proper oil return.

C. Size lines for total pressure drop not to exceed 2ºF saturation temperature.

D. Provide necessary flexibility for vibration and expansion with offsets and loops, not expansion joints.

E. Provide flexible connectors at all unit connections.

F. Replace air in pipe with dry nitrogen to prevent corrosion during soldering.

G. Install valves, sight glasses, filter-driers, and accessories, furnished by equipment supplier, but not factory installed.

H. Insulate all underground refrigerant lines with ½" flexible foam. Use unslit covering and carefully cement all joints.

3.2 HANGERS

A. For insulated piping, provide hangers of size to fit outside insulation.

B. For non-insulated piping, provide hangers with elastomer insert to prevent damage to piping from vibration.

C. All refrigerant lines must be supported by Unistrut (or equal) hangers and supports. Horizontal suction lines (insulated) may lie on hangers without being clamped, provided they are reasonably fee of movement and secure from vibration. All vertical liquid and suction lines must be clamped. All discharge piping to and from remote air cooled condensers shall also be securely clamped to supports. Clamp assemblies shall be manufactured by Hydra-Zorb, or approved equal.

D. All lines that require clamping shall be installed according to the following recommend spacing:

Line Size	Maximum Span
5/8" and smaller	5'-0"
1-1/8"	7'-0"
1-3/8"	8'-0"
1-5/8"	9'-0"
2-1/8"	10'-0"

3.3 TESTING AND DEHYDRATION

A. Refrigeration piping shall be tested in accordance with the recommendation of the refrigeration equipment manufacturer and in the following sequence for a period of 24 hours:

High Side – Nitrogen at 300 psi
Low Side – Nitrogen at 150 psi
Entire System – Refrigerant at 5 psi

B. No visible leaks, losses in pressure or increase in vacuum shall occur during test period.

C. Use the following procedure to test and hydrate the systems:

1. Isolate any elements which would be damaged by test pressures.
2. Test system with trace gas using an appropriate leak detector.
3. Repair or replace leaking elements of system and re-test.
4. After system has been proven to be free of leaks, evacuate it with a high efficiency vacuum pump to 2.5 mm of mercury absolute, to blow off the pressure in the system to atmosphere and provide final evacuation. Use a Zimmerli gauge to read vacuum. Remove all moisture from the system. Operate the vacuum pump until a vacuum of 2.5 mm Hg. is achieved.
5. Allow the system to stand under vacuum for 24 hours.
   a. Then, if a vacuum of 2.5 mm can be drawn within 30 minutes, the system shall be considered dry.
   b. If not, the procedure shall be repeated. Break the vacuum with oil pumped, dry nitrogen, open the compressor suction and discharge service valves and re-evacuate the system to 2.5 mm Hg. absolute. If no noticeable rise in pressure has taken place after 24 hours, the system shall be charged.
6. Break the final vacuum by charging with the correct refrigerant. Refrigerant shall be charged in strict accordance with CFR 40 requirements for refrigerant handling.

3.4 START-UP AND CHECK-OUT

A. In additional to the manufacturer's recommended start-up procedures, the following parameters are to be recorded once the system is stabilized.

Compressor voltage (all phases)
Compressor current (all phases)
Compressor suction pressure/temperature (and superheat)
Compressor discharge pressure/temperature
Evaporator coil suction superheat (not to exceed 10°F)
Outside air temperature

These readings are to be included in the O&M Manual when start-up is complete.

B. All replaceable core filter and filter-drier elements shall be replaced by the Contractor thirty (30) days after system start-up.

C. A final acceptance will only be made after inspection by an authorized representative of Vassar from the Department of Planning, Design and Construction.

END OF SECTION

SECTION 23 25 13

CLOSED SYSTEM WATER TREATMENT

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install chemical treatment systems for closed hydronic systems where shown on the Drawings and as specified in this section.

B. Work under this section shall include providing equipment, chemicals, and service related to water treatment for the geothermal/condenser and solar thermal water systems.

C. The Contractor shall engage the services of a water treatment contractor who shall provide a complete water treatment service. The service shall include furnishing and application of all chemicals, at least one visit a month to collect samples for chemical analysis at the water treatment company's laboratory, and all necessary inspection, adjustment, and maintenance of the chemical treating devices. Complete chemical control of the treatment shall be included. Reports shall be furnished to Architect after each visit.

D. Water treatment shall be applied concurrently with the operation of each circulating water system for a period of one year. An initial dose of treatment chemical shall also be applied immediately after each system is initially filled with water if operation is to be delayed after filling. In addition to the chemicals indicated, slimicides and algeacides shall be provided as necessary. Chromate and phosphate will not be acceptable. All chemicals shall be approved by local and state agencies having jurisdiction.

E. The firm's water treatment laboratory shall be equipped to analyze water in accordance with the statement methods of the American Public Health Association.

F. Water treatment contractor shall provide chemical feeding devices during the period of this contract. At the termination of the contract, the treatment equipment shall belong to the Owner.

G. Provide a water treatment program for the following systems:

Geothermal/Condenser water systems.
Solar thermal water system.

H. Provide a comprehensive program of cleaning and flushing for geothermal/condenser water system.

I. All chemicals and formulations prescribed for the cleaning and treatment of process water systems must meet the following specified criteria:

1. They must be ecologically compatible so that any discharge will not create an environmental impact.
2. They must be industrial and toxicologically safe so as to minimize personnel and equipment exposure to hazardous conditions.
3. Every effort must be made to maintain a sense of uniformity in chemical formulation to insure a line of continuity.

J. Provide permanent signage on hydronic systems treated with chemicals that include the following information:

1. Chemical type, concentration, and system volume.
2. Direction to drain system to sanitary drain.

K. Chemical type, concentration and system volume shall be stenciled on the system expansion tank in a visible location.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 21 13 Hydronic Piping And Accessories

1.3 QUALITY ASSURANCE

A. The chemical treatment program shall be administered by a firm regularly engaged in the field of water treatment with a minimum of five years experience in the immediate area of the job site location, and similar sized projects.

B. The water treatment contractor shall have laboratory facilities, both central and field, to service the Owner's account.

C. The water treatment contractor shall have local warehousing and will not be allowed to overstock chemical on premises.

D. A single water treatment company shall be responsible for all products and services.

E. Approval Process: All materials proposed for application must have the prior approval of the Engineer and Owner. In order to thoroughly evaluate the products performance, it is recommended that the following be submitted at the time of proposal:

1. Material Safety Data Sheets for all products that are to be applied, which shall contain the complete formulation. Further documentation of qualitative composition must be included if Material Safety Data Sheets do not supply all product(s) components.
2. Product Data Sheets specifying overall product description and application guidelines.
3. Methods of analysis for determining product residuals. Proposals should specify specific qualitative and quantitative procedures of evaluating actual product levels. They should also include recommended parameters for all products, expressed in either terms of parts per million or milligrams per liter.
4. Expected performance levels of products; this should include expected corrosion rates, expressed in mils per year. If the product is of a biostatic nature, what levels of biological growth should be expected if the product is applied at recommended dosages.
5. Provisions should be submitted for the removal for any unused chemicals. In addition, provisions must be provided for the disposal of all empty containers.

F. The above mentioned criteria will serve as a guide as to the minimum information required for approval of any chemical treatment. No water treatment shall be purchased, delivered, or applied without consideration of the previously mentioned guidelines.

1.4 SUBMITTALS

A. Provide product data for each piece of equipment installed the system and for each chemical used.

B. Provide shop drawings for control panel, including internal and external wiring diagrams, dimensions, etc.

C. Provide operation and maintenance manuals for all equipment.

D. Material Data Safety Sheets shall accompany all chemicals delivered to the job site.

PART 2 - PRODUCTS

2.1 PRE-STARTUP CLEANER

A. Furnish pre-startup liquid detergent dispersant cleaner for flushing and cleaning of water systems to remove oil and foreign matter from piping and equipment prior to final filling of systems. Chemical shall not be injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps, and their mechanical seals, tubes, or other parts of the system.

B. This work shall include the internal cleaning and protective coating of all distribution systems on this construction such as, but not limited to, solar thermal, geothermal/condenser water and solar thermal water systems and components.

C. This method of cleaning and treating is to be applied to all piping supply and return and then back to the source of equipment.

D. In all systems the process shall be completely circulated throughout, and afterwards the system is to be drained, flushed and protective coated. The Contractor shall engage the services of a cleaning firm, for the purpose of removing lime, oil, grease, oxides and other wastes therefrom. Strainers and all points of piping systems shall be effectively flushed. After the removal of these impurities, a protective coating shall be applied to all inner surfaces, which will inhibit oxidation as well as protect the metals against impurities that may be present in the water. This coating shall be guaranteed for five years from date of completion at no cost to the Owner, covering labor and materials. Valve-off heat exchangers to avoid coating surfaces.

E. The cleaning and testing materials use for this purpose must have been in use successfully for at least five years in comparable systems. Building system pumps shall not be used in system cleaning procedures.

F. It shall be compounded of non-corrosive, non-toxic, non-alkaline and non-injurious ingredients that have been investigated and reported as a "Neutral Compound" by a recognized engineering firm or laboratory, other than the submitting company's own laboratory. Brochures and unbiased test reports shall be submitted to the Architects within 90 days from job acceptance for approval. This cleaning and treating firm shall show proof, that said firm has been established and accepted for this work, for a minimum of 10 years. The ingredients used shall have no deleterious effects on seals, O-rings, glands, packing, etc.

G. It shall be the sole responsibility of the approved firm for the application of this process. He shall supply all labor, materials, and equipment for this purpose. A competent supervisor and/or equipment operator shall be kept at the site from commence of his work until completion. None but experienced men shall operate this pumping equipment. Any repairs or servicing of components of these systems shall be done by the Contractor.

H. Cleaning procedures for newly installed systems shall be as follows:

1. Step 1: Adjust all control valves and balancing valves to full open position during the cleaning and treatment process.
2. Step 2: Fill system and add standard 12% hypochlorite bleach for a residual of 2-3 parts per million (ppm) chlorine. This should require approximately one quart of bleach per 10,000 gallons of water. Test for concentration. Circulate solution for a minimum of eight hours. Clean strainers and dead end piping legs, then drain to sanitary sewer
3. Step 3: Fill system and add a general dispersant for iron, mud, silt, and microbiological matter at a concentration of 500-1000 parts per million (ppm), or approximately seven gallons of product per 10,000 gallons of water. Test for concentration. Circulate solution for a minimum of eight hours. Flush system using bleed and feed until the bleed water pH and iron levels are consistent with the feed domestic water levels. Clean strainers and dead end piping legs.
4. Step 4: Arrange for inspection by a representative from the Facilities Management Pipe Shop before proceeding to chemical treatment.

I. For extensions to existing building systems, the above cleaning procedures shall be followed if the extension contains ferrous piping materials. Provide temporary piping, valving, and pumping system isolated from the existing building system as needed to perform cleaning procedures prior to final connection to the existing building system.

2.2 CHEMICALS

A. A buffered Molybdate and/or Nitrite based corrosion inhibitor shall be provided to initially treat the closed systems and added as required for 1 year from date of owner acceptance. This treatment must contain a copper inhibitor and a borate buffer.

B. Any treatment must be compatible with glycol installed in glycol/water systems.

C. Treatment chemicals for hydronic solar thermal and geothermal/condenser water cooling systems shall be as follows:

1. Non-Glycol Systems: After cleaning and inspection, immediately add a molybdate based corrosion inhibitor. Acceptable corrosion inhibitors shall include a combination of sodium molybdate, sodium hydroxide, tolytriazole and organic polymers. Test for residual concentrations as follows:

   a. Molybdate: 100 ppm
   b. pH: 8.3-9
   c. Tolytriazole: 5 ppm

2. Glycol Solar Thermal Systems: After cleaning and inspection, drain system then refill with Metro PG#36 propylene glycol (PG) solution at a concentration of 50% propylene glycol to 50% water. The water to be added to glycol solutions shall meet manufacturer's standards for quality.
3. Glycol Geothermal Water Systems (Ground Loop): After cleaning and inspection, drain system then refill with Metro PG#36 propylene glycol (PG) solution at a concentration of 25% propylene glycol to 75% water, in accordance with manufacturer's recommendations. The water to be added to glycol solutions shall meet manufacturer's standards for quality.
4. Glycol Condenser Water Systems (Building Loop): After cleaning and inspection, drain system then refill with Metro PG#36 propylene glycol (PG) solution at a concentration of 30% propylene glycol to 70% water, in accordance with manufacturer's recommendations. The water to be added to glycol solutions shall meet manufacturer's standards for quality.

D. Arrange for inspection by a representative from the Facilities Management Pipe Shop prior to final acceptance.

2.3 POT FEEDER

A. Provide a five (5) gallon pot feeder piped around the main Solar Thermal Water and Geothermal/Condenser Water circulating pumps as indicated on the drawings. The feeder shall consist of a steel tank with operating pressure of 200 psi. A 3½" quick open cap with "O" ring seal shall be provided to add water treatment chemicals.

2.4 COUPON HOLDER

A. Provide coupon rack with coupon holders, flow control and isolation valves. Coupon racks shall be installed in all closed and open systems that are being treated.

B. Coupon Holders shall be similar to Pulsafeeder, Inc. Model CCR-4.

C. The Water treatment contractor shall install the coupons in the coupon holders and submit a written report to the Owner at the end of each 90 days, during the one year warranty period as to the condition of each system being treated.

2.5 CLOSED SYSTEMS – GLYCOL FEEDER

A. Glycol Feeder Assembly

1. Provide and install equipment for the automatic feed of a glycol solution. System components shall be as specified.
2. Feeder storage tank assembly shall consist of one (1) 55 gallon polyethylene tank with cover equipped with two (2) 3/4" bulkhead fittings located 3" from the bottom of the tank for pump suction and drain. The storage tank shall be mounted on a steel tank stand equipped with a side mounting platform for the glycol pump. Tank and stand assembly shall be H-O-H Model S-50 or equal.
3. Glycol feed pump shall be Oberdorfer Model 992MJ-07, ½ HP, 1725 RPM.
4. Glycol control panel with red low level warning light, alarm bell, alarm silence switch and hand/off/auto switch, prewired with terminal strip connections in NEMA 1 enclosure. Glycol system control panel shall be H-O-H Model GLC-10 or equal. Provide level alarm at BMS.
5. Pressure relief valve shall be Neptune Model RV316-1 or equal, relief setting shall be as required for the project.
6. Pressure switch for glycol pump control shall be adjustable to provide glycol pump start/stop. Ranges: 5 to 65 psi differential 12 psi – Furnas Model 69WA4.
7. Low level drum caddy shall shut off glycol pump in the event of low glycol level in storage tank. Caddy shall be wired for pump disconnect and warning device activate circuits, and shall be LMI Low Level Switch.

B. Glycol

An inhibited industrial grade propylene glycol shall be furnished for proper percentage of glycol solution within the system. Refer to Section 23 21 13 for glycol requirements.

C. Test Equipment

Furnish a hydrometer type test kit for the determination of percent/freeze point of glycol solutions.

2.6 WATER TREATMENT CONTROL TESTING EQUIPMENT

A. Provide a test set complete with apparatus and chemical regents for the determination of phosphonate (ortho), ph (7.6 - 9.2), nitrite and any additional test as required by water treatment company.

PART 3 - EXECUTION

3.1 Provide a one year supply, from date of startup, of the recommended formulas for the prevention of scale, corrosion, and biological growth in the recirculating system.

3.2 All formulations must be compatible with system construction materials and meet or exceed all environmental requirements.

3.3 The water treatment company will supply all testing equipment and reagents, necessary to properly maintain the treatment program.

3.4 The water treatment company will provide a water treatment service program for a period of one year from system startup. This program shall include: startup assistance, plant personnel training, monthly service calls and inspection of system equipment. Provide owner with copy of field service report including performance test required levels vs. Field measurements.

3.5 Provide quarterly laboratory analysis and report of coupons.

END OF SECTION

SECTION 23 31 13

DUCTWORK

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Fabrication and installation shall be by a single firm specializing and experienced in metal ductwork for not less than 10 years.

B. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors National Association) recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

C. Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), except as otherwise indicated.

D. Compliance with SMACNA and ASHRAE is a minimum requirement. In case of disagreement between sheet metal work described in this Section and SMACNA or ASHRAE, the specification shall govern, unless the requirements of SMACNA or ASHRAE are of greater value.

E. Comply with SMACNA “HVAC Air Duct Leakage Test Manual” for testing of duct systems.

F. Comply with New York State Energy Conservation Code for UL Listing of products.

G. Comply with NFPA 90A.

1.2 SUBMITTALS

A. Detailed ductwork shop drawings, which include sizes, layouts, and pressure classifications, must be properly submitted. Any ductwork installed without prior written approval by the engineer of record shall be replaced at the expense of the contractor.

B. Shop Drawings: Submit shop drawings for:

1. Transition elbows.
2. Seal and reinforcing schedule for all ductwork fabrication types.
3. Turning vane and turning vane installation.
4. Coordinated duct routing and sizes.

C. Product Data: Submit manufacturer’s product data including VOC content on the following:

1. Duct lining.
2. Duct lining adhesive.
3. Duct sealant

1.3 PRODUCT HANDLING

A. Protect shop fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Protect ends of ductwork and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

1.4 QUALITY ASSURANCE

A. The contractor must comply with the specification in its entirety. If on inspection, the engineer of record finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification at the contractor's expense.

B. At the discretion of the engineer of record, sheet metal gauges and reinforcing may be randomly checked to verify all duct construction is in compliance.

C. All ductwork and fittings must have a computer generated label affixed to each section detailing all applicable information including the duct dimensions, gage, reinforcement type/class, and connector type of systems manufacturer. In addition, galvanizing thickness and country of origin must be clearly displayed on each duct section.

D. Duct sealing shall be sealed as per requirements of SMACNA Air Duct Leakage Test Manual.

1.5 GUARANTEE

A. Contractor will guarantee all work for one year from the date of acceptance against all defects in material, equipment and workmanship. This guarantee shall include repair of damage to any part of the premises resulting from leaks or other defects in material, equipment or workmanship.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTWORK

A. Construct ductwork to meet the functional criteria defined in Section VII of the 2005 SMACNA "HVAC Duct Construction Standards, Metal and Flexible," Second Edition.

B. All ductwork must comply with any applicable local, state, and federal code requirements.

C. Furnish and install the size, connections and run of ducts as indicated on the Drawings. All dimensions represent inside clear dimensions.

D. While the drawings shall be adhered to as closely as possible, the Engineer reserves the right to vary the run and size of ducts during the progress of the work if required to meet structural conditions.

E. Install all ductwork in strict adherence to the ceiling height schedule indicated on the Architect's Drawings. Consult with the Electric and Plumbing Contractors, and in conjunction with the above Contractors, establish the necessary space requirements for each trade.

F. The sheet metal ductwork shall, whether indicated or not, rise and/or drop and/or change in shape to clear any and all conduits, lighting fixtures, plumbing and heating mains to maintain the desired ceiling heights.

G. The ductwork shall be continuous, with airtight joints and seams presenting a smooth surface on the inside and neatly finished on the outside. Ducts shall be constructed with curves shown on the Drawings, the inside radius of all curves and bends shall be not less than width of ducts in plane of bend.

H. All shower exhaust ductwork up to a distance as indicated on the drawings but not less than 15'-0" from the registers shall be aluminum construction. All joints shall be sealed tight with Foster 32-19, Childers CP-146 or Ductmate PROseal UL 181B-M listed sealer or approved equal. Ductwork shall pitch toward the registers.

I. Gauge of stainless steel duct shall be same as for steel duct. Seal with Foster 32-19, Childers CP-146 or Ductmate

PROseal or approved equal.

J. Provide 12" x 12" access doors for every 50'-0" run of supply and return air duct and at the base of each vertical riser for cleaning purpose.

K. All outside air intake ducts between intake point and air handling unit or mixed air duct or plenum shall be aluminum or stainless steel construction with all joints sealed with Foster 32-19, Childers CP-146 or Ductmate PROseal UL 181B-M listed sealer.

L. All air ducts exposed to the weather and not insulated shall be constructed of aluminum or stainless steel and shall be properly braced and supported and secured to the building construction. All seams shall be sealed with Foster 32-19, Childers CP-146 or Ductmate PROseal UL 181B-M listed sealer.

1. The construction of ductwork shall be same as conventional ductwork except where transverse reinforcing angles not required, provide 1" x 1" x 1/8" black iron bracing angles matched angles at joint and 1" x 1" x 1/8" black iron between joints 4'-0" from joints.
2. Provide 1/8" thick gasket (3M EC-1202 or equal) for all matched angles.
3. Edge of ducts shall be bent 1/2" over matched angles to obtain watertight seal.
4. Rivet angles to duct and seal with Foster 32-19, Childers CP-146 or Ductmate PROseal UL 181B-M listed sealer.
5. Paint bare steel iron angles black after installation.

M. Where dimensions, sizes, and arrangements of elements of duct assembly and support systems are not provided in these standards the contractor shall select configurations suitable for the service.

N. The contractor shall follow the application recommendations of the manufacturer of all hardware and accessory items and select them to be consistent with the duct classification and services.

O. Where sealing is required it means the following:

1. The use of adhesives, gaskets, tape systems, or combinations of these to close openings in the surface of the ductwork and field-erected plenums and casings through which air leakage would occur or the use of continuous welds.
2. The prudent selection and application of sealing methods by fabricators and installers, giving due consideration to the designated pressure class, pressure mode (positive or negative), chemical compatibility of the closure system, potential movement of mating parts, workmanship, amount and type of handling, cleanliness of surfaces, product shelf life, curing time, and manufacturer-identified exposure limitations.
3. That these provisions apply to duct connections to equipment and to apparatus.

P. Transverse joints for all supply, return, make-up air and outside air ducts serving an application that requires ductwork to be inspected and cleaned periodically shall be gasketed flanged Vanstone joints with minimum 1.5 inch flanges fastened 6 inches on center or “Ductmate” transverse sheet metal duct connection system with manufacturer-furnished gasketing system. Gasket shall be “440 Gasket Tape” by Ductmate Industries, inc. or approved equal.

Q. Duct transverse and longitudinal joints (except for the above requirements) shall be selected and used consistent with the static pressure class, applicable sealing requirements, materials involved, duct support intervals and other provisions for proper assembly of ductwork outlined in the SMACNA HVAC Duct Construction Standards – Metal and Flexible. Transverse joints T-15 through T-24, shown in Figure 2-1 are acceptable construction. Type L-2 (button punch snap lock) or Type L-3 (grooved seam) longitudinal seams, shown in Figure 2-2, are not acceptable.

R. Seal all ductwork seams, joints, fastener penetrations and fitting connections with sealants in accordance with SMACNA Seal Classification as required by SMACNA Duct Pressure Classification. All ductwork, regardless of pressure classification, shall have a minimum Seal Class A. Where ducts are not continuously welded, provide liquid, mastic, and embedded fabric tape type sealants or combination, and gaskets as required to meet the specified

duct leakage allowance. Sealant composite fire and smoke rating, when tested in accordance with ASTM E 84, NFPA 255 or UL 723, shall not exceed Flame Spread of 25 and Smoke Developed of 50.

S. The aspect ratio (ratio of width to height) of rectangular ducts should be minimized to reduce pressure losses and initial costs. Duct aspect ratios should not exceed 4:1.

2.2 DUCT PENETRATIONS THRU FLOOR

A. Provide 4" high and 4" wide concrete pad all around opening at duct penetrations thru floors. Fill in space between duct and floor construction with mineral wool and fire rated sealant.

2.3 DUCTWORK MATERIALS

A. All interior ducts shall be constructed with G-90 or better galvanized steel (ASTM A653/653M) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (i.e. kitchen exhausts) shall also be G-90 or better galvanized steel LFP, chem treat.

B. Stainless steel duct shall be fabricated from lock forming grade, 300 series, ASTM-AI67, No. 4 general purpose finish. Protect finish with mill applied adhesive protective plastic/paper throughout construction.

C. Ungalvanized carbon steel shall be lockforming grade, hot rolled steel conforming to ASTM A366 or A619.

D. Flexible Duct shall be factory constructed and listed in accordance with UL 181. Integral fiberglass or mineral fiber insulation shall provide a U value of .25.

2.4 PERMITTED DEFLECTION

A. Joints

1. Up to 48" wide – ¼"
2. 49" – 120" – W/200

B. Sheet

1. 12" and less – 3/8"
2. 13" – 18" – ½"
3. 19" – 24" – 5/8"
4. 25" – 84" – ¾"
5. 85 and larger – 1"

C. Reinforcement

1. Provide mid-panel tie rod, reinforcement and /or where required to control deflection within indicated limits. Details of construction and attachment shall be per SMACNA.

2.5 RECTANGULAR DUCT

A. Construct rectangular ductwork in accordance with Section II and to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible", 2005 Edition. All ductwork must comply with all local, state and federal code requirements.

B. All rectangular ductwork, unless otherwise noted, shall be built from galvanized sheet steel and thoroughly braced and stiffened

C. Where the standard allows the choice of external reinforcing or internal tie rods, only the external reinforcing options shall be used.

D. Pittsburgh lock shall be used on all “rectangular” duct longitudinal seams. All longitudinal seams shall be sealed with an approved sealant or pre-sealed with an encapsulated mastic or butyl E.P.D.M. rubber on all rectangular duct.

E. Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.

F. Ductmate or W.D.C.I. proprietary duct connection systems will be accepted. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.

G. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) shall be constructed as SMACNA T-25 flanges, whose limits are defined on Page 1.36 1995 SMACNA Manual, Second Edition. No other construction pertaining to formed on flanges, will be accepted. Formed on flanges shall be accepted for use on ductwork 42” wide or less, 2” static (positive) or less and must include the use of corners, bolts and cleat.

H. Ductmate type systems that use a butyl Rubber Gasket which meets Mil-C 18969B, Type II Class A, TT-C-1796 A, Type II Class A, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth (as defined in 21CFR 177, 1210 closures with sealing gaskets for food containers).

I. Aluminum duct shall be fabricated using the aluminum thickness equivalence table in the standard. Simply increasing the thickness by two gauges is not acceptable.

J. Fittings shall be constructed and reinforced as ductwork according to the longest span.

K. For duct construction pressure 2” w.g. or below based on external static pressure of fan:

1. Flat areas of duct over 18 in. wide shall be stiffened by cross breaking or beading.
2. All joints to have corner closures.
3. All joints shall be sealed with Foster 32-19, Childers CP-146 or Ductmate PROseal UL 181B-M listed mastic.

L. For duct construction pressure 2-5” w.g. based on external static pressure of fan:

1. All seams on fitting shall be continuously welded. If the zinc coating is burned off the steel during welding, apply zinc chromate paint to prevent corrosion.
2. Companion angles shall be bolted to each other with 1/4 in. x 3/4 in. stove bolts, spaced not more than 6 inches apart.
3. Hangers shall be as described for conventional ducts, except that they shall be fastened to the reinforcing angles, or angle connections. Where this is not feasible cradle hangers with a bottom angle shall be used; angle shall be suspended by angles or rods. Piercing of ducts by hangers, pipes, fasteners, etc., will not be permitted.

2.6 ROUND AND OVAL DUCT

A. Round and oval duct shall be galvanized steel, constructed in accordance with SMACNA “Duct Construction Standards, Metal and Flexible”, except as noted. Duct shall be minimum 22 gauge. Submit product data sustaining the equivalency of such duct into SMACNA standard duct.

B. Provide flat side reinforcement of oval ducts as recommended by SMACNA standards. Do not use internal tie rod reinforcement unless specifically approved by Engineer.

C. Round ductwork shall be spiral lock seam for round ductwork systems higher than 2". Example: Ductmate, Greenseam or approved equal. Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted.

1. Joints 0"-20" diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3-inch wide duct tape.
2. Joints 21"-72" diameter, use 3 piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.
3. Hangers shall be as described for conventional ducts, except that they shall be fastened to the reinforcing angles, or angle connections. Where this is not feasible cradle hangers with a bottom angle shall be used; angle shall be suspended by angles or rods. Piercing of ducts by hangers, pipes, fasteners, etc., will not be permitted.

D. Fittings shall be continuously welded, standing seam, or spot welded and sealed. Metal thickness and reinforcing shall be equivalent to the requirements of the largest span.

1. All elbows greater than 45" shall be radius type, R=1.5 times duct diameter.
2. Elbows less than 12" shall be of die stamped construction. Elbows 12" or greater shall be 5-piece construction.
3. Diverging and converging flow fittings shall be constructed with no excess material projecting from the body into the branch tap entrance. All such fittings shall be 45° "shoe" entrance, wye plus elbow, or 45° lateral branch. Special fittings such as heel tapped elbows and bullhead tees may be used only where shown on drawings. Adjustable elbows and straight saddle taps shall not be used. Low pressure adjustable elbows acceptable.
4. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA standard.
5. Coat galvanized areas of fitting damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.

E. For duct construction pressure 2" w.g. or below:

1. Longitudinal seam sealed, self-locking snaplock duct is acceptable for round ductwork systems of 2" w.g. and lower.
2. All round snaplock pipe longitudinal seams shall be sealed with an E.P.D.M. rubber on all round self-locking longitudinal round pipe. Approved Manufacturer: Ductmate Industries "Green Seam" self-locking longitudinal round pipe or approved equal.

2.7 KITCHEN HOODS (GREASE LADEN DUCT)

A. All ductwork shall be constructed with continuously welded seams and continuously welded joint connections as per NFPA 96. The exterior of all kitchen hood exhaust ducts shall have 1-1/2" x 1-1/2" x 1/8" welded angles, punched for securing block insulation. Where kitchen hood exhaust duct risers pass vertically through floors of the building, provide angle clips welded to the duct of required sizes to support the weight of the riser sections on the building's structure at each of the floor levels. Provide and install all supplementary structural steel in shafts to properly support exhaust ductwork from building construction. The portion of ductwork exposed to view in the kitchen shall be 12 gauge and the same material as the hood. Hood ducts shall conform to NFPA #96.

B. All interior exhaust ductwork shall be 12 gauge welded black iron.

C. All exterior exhaust ductwork shall be 16 gauge welded stainless steel. Provide a permanent sign identifying the facility from which the duct originates at the base of each duct and at its termination point.

D. Maintain all clearance requirements as specified by the NYCBC.

E. All horizontal kitchen exhaust ductwork shall be pitched towards the hood or toward an approved grease reservoir.

1. Horizontal duct runs less than 75 feet in length shall be pitched not less than ¼" per foot (2% slope).
2. Horizontal duct runs 75 feet and greater in length shall be pitched not less than 1" per foot (8.3% slope).

F. Provide a residue trap at the base of each vertical riser with provision for cleanout in accordance with NFPA 96 and NYCBC.

G. Provide 18" x 12" insulated double wall access door (cleanout) on the side or top of duct. Access doors shall seal tightly and be designed so that they are operable without the use of a tool. Cleanout openings shall meet all the requirements of the NYCBC.

H. Provide access doors at the following locations:

1. Every change in direction.
2. Within three feet of the exhaust fan.
3. At the base of a vertical riser and at every floor.
4. At a 12' spacing along length of duct.
5. As indicated in the NYCBC.

I. All access doors shall located in serviceable locations.

J. Exhaust outlets terminating above the roof shall have a discharge opening located not less than 42" above the roof surface. Flows shall be directed away from the surface of the roof.

K. All kitchen exhaust ductwork shall be permanently labeled "CAUTION: KITCHEN EXHAUST SYSTEM".

L. Duct located within 24" of doors or windows or where accessible to the public shall be provided with insulation or guards to prevent contact with the duct.

M. Duct joints shall be welded butt joints ground clean on the duct interior. Overlapping joints shall be constructed in accordance with code requirements limiting impingement on air stream and overlap.

N. Provide approved fire dampers at locations where grease duct system is extended to serve a device other than a kitchen hood.

O. Ductwork shall be wrapped with zero-clearance, 2-hour, UL rated, duct wrap. Provide a minimum of two layers for zero clearance and a vertical chase to maintain the "separate chase" definition of the NYC modified IBC. Access doors shall be constructed to allow removal and reinstallation without damage to firewrap.

2.8 ALUMINUM DUCTWORK

A. Where transverse reinforcing angles are not required provide 1"x1"x1/8" black iron matched angles at joints and between joints at a maximum spacing of 4 feet.

B. Provide 1/8" thick gasket at all matched angles. Edge of duct shall be bent ½" over matched angle to obtain watertight seal. Rivet angle to duct and seal with listed sealer. Paint black iron angles prior to installation.

C. Aluminum ductwork shall be fabricated using the aluminum thickness specified in the standard. Increasing galvanized gauge by 2 gauges is not acceptable.

D. Aluminum duct shall be fabricated from lock forming grade, ally 3003-HI4, ASTM B209. Reinforcing angles, bars, tie rods, and other structural members shall be alloy 6061-T6. Hangers shall be 6061-T6 aluminum, or galvanized or

painted steel with a dielectric isolation pad between the dissimilar metals.

2.9 EXTERIOR INSULATED DUCTWORK

A. Exterior insulated ductwork shall be constructed as double wall aluminum duct with a 2" interstitial space packed with insulation.

B. Top of duct shall be sloped to drain at ¼" per foot.

C. Ductwork observed to pond water shall be replaced by contractor at his expense.

D. Wrap exterior of ductwork in one layer of EPDM roofing with seams sealed to prevent water entry. Seams shall be arranged to shed water.

2.10 EXTERIOR UNINSULATED DUCTWORK

A. Top of duct shall be sloped to drain at 1/4" per foot.

B. Any ductwork observed to pond water shall be replaced by contractor at his expense.

2.11 SOUND LINED DUCTWORK

A. Sound lined ductwork shall be constructed with an exterior layer suitable for environment and a perforated inner wall constructed of the same material as the duct. Inner lining shall be 3/32" diameter holes approximately 22% open area.

B. Sound lining shall be installed in a minimum 2" interstitial space between layers.

2.12 FLEXIBLE DUCTWORK

A. Duct shall conform to NFPA 90 and be UL listed.

B. Insulation shall be on the exterior of duct.

C. Maximum length shall be 6 feet or less.

D. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.

E. Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).

2.13 VAPOR LADEN DUCT

A. Material: 22-gauge aluminum.

B. Seams: Seal all seams watertight.

C. Ducts shall be pitched to be self-draining. Where necessary pitch is not possible provide a trapped drain pocket piped to sanitary sewer at all low points. Provide access door at all drain pockets.

D. Provided welded stainless steel duct upstream and downstream of humidifier. Duct shall be 3 feet long upstream of humidifier and 6 feet downstream of the humidifier.

2.14 DISHWASHER HOOD

A. Ductwork for dishwasher hood: Ductwork for dishwasher hood shall be of 18 gauge stainless steel type 304 all welded construction and pitched back to hood. Low points, base of riser, and bottom of fan scrolls shall be piped to drain.

B. Drainage:

1. Provide 1" gutter on all sides.
2. Provide ¾" coupling and plug in bottom of gutter.

2.15 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Provide miscellaneous materials and products of the types and sizes indicated, and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Double wall turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert table, which align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs. when fastened per the manufacturers instructions. Approved Systems: Ductmate PRO-Rail.

C. Single wall splitter and turning vanes shall be custom fabricated as specified below.

D. Ductwork Support Materials: Except as otherwise indicated, provide galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

E. Duct Sealant:

1. Products:

a. United McGill
b. Ductmate Industries, Inc., PROSeal
c. Hardcast, Versa-grip 181
d. Precision
e. Uni-Mastic 181 Duct Sealer, UL Listed - Indoor
f. Unicast, PROseal - Outdoor

2. Description: Non-hardening, liquid or mastic elastic sealant.
3. Fire Rating: UL 289U listed and NFC 220(b).
4. UL listed: UL 181A/B listed

2.16 DUCT TAPE ROLLED SEALANT SEALING SYSTEM

A. Manufacturers:

1. Design Basis: Hardcast. Foil-Grip 1402 181B-FX, UL listed.

B. Model:
1. Tape: DT
2. Indoor Adhesive: FTA-20

3. Outdoor Adhesive: RTA-50

2.17 FIBERGLASS DUCTBOARD

A. Fiberglass ductboard is not accepted without prior written approval from the specifier.

2.18 ACCESS DOORS

A. Wherever necessary in ductwork, casings or sheet metal partitions, provide suitable access doors and frames to permit inspections, operation and maintenance of all valves, coils, humidifiers, controls, smoke dampers, smoke detectors, fire dampers, filters, bearings, traps, or other apparatus concealed behind the sheet metal work. All such doors shall be of double construction of not less than No. 20 gauge sheet metal and shall have sponge rubber gaskets around their entire perimeter. Doors in insulated ducts of insulated casings shall have rigid fiberglass insulation between the metal panels.

B. All access doors in sheet metal ducts shall be hung on heavy flat hinges and shall be secured in the closed position by means of cast zinc clinching type latches. Where space conditions preclude hinges, use four heavy window type latches.

C. Doors into ducts shall in general not be smaller than 18" x 18" except for access door to fire dampers which will depend on size of fire damper.

D. Provide insulated or acoustically lined doors to prevent condensation where applicable.

E. Systems 3” w.g. or less shall utilize a hinged, cam, or hinged & cam square-framed access door.

F. Grease exhaust duct doors shall be grease and air tight, UL 1978 listed, meet NFPA 96 standards and all mechanical codes. Grease duct access doors can be sandwich type or with a weld on frame, with/without hinge. Approved Manufacturer: Ductmate Industries “Ultimate” style door or approved equal.

G. All grease duct access doors used must be accompanied by independent testing in conjunction with each manufacturer’s respective wrap system for high temperature applications.

2.19 FLEXIBLE DUCT CONNECTOR

A. Flexible duct connector shall be used where ductwork connects to fans of apparatus, or apparatus casing to fans so as to prohibit the transfer of vibration from fans to ductwork connecting thereto. Connectors will meet NFPA 90A and 90B specifications and provide an airtight and waterproof seal. Indoor installations shall be Neoprene or vinyl coated fabrics. Outdoor installations shall use Hypalon coated fabric. Connector shall be Ductmate PROFlex or approved equal.

B. The flexible connections shall be a minimum of 12" long including bands using extra wide fabric as specified and held in place with heavy metal bands, securely attached, to prevent any leakage at the connection points. The fabric shall have a maximum length of 10”.

C. Flexible connections shall be fabricated from an approved flame retardant fabric each having a maximum flame spread index/rating of 25 and a maximum smoke developed ration of 50.

Range hood exhaust Installations shall be Flame-Proof Silvaseal by Duro Dyne, Ductmate PROflex Neoprene, or equal.

Low Pressure Systems	- neoprene coated glass fabric - 30 ounce/sq. yd.
Medium & High Pressure Systems	- neoprene coated glass fabric - 30 ounce/sq. yd.

D. Flexible connections shall not be painted.

E. Flexible connections shall be installed between all rigid ductwork or casing and all air handling equipment.

2.20 ROOF MOUNTED DUCT SUPPORTS

A. Duct on roof shall be supported by an engineered prefabricated system specifically designed to be installed on the roof without roof penetrations, flashing or damage to the roofing material. The system shall consist of linear curbs with spread bases located along the length of the duct with a trapeze constructed to support the underside of the duct. The system shall be custom designed to fit the duct to be installed and the actual conditions of service. Loading shall not exceed 15 PSF of bearing surface.

B. Duct finishes shall be constructed independently of the support system and shall not be enveloped in the support system.

C. Curbs shall be located to bear on structural elements of the roof deck, not the roof deck itself.

2.21 SEISMIC RESTRAINTS

A. Provide seismic restraints as required for seismic zone.

2.22 HANGER AND SUPPORT MATERIALS

A. Hang and support ductwork as defined in Section 5 of the 2005 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Third Edition or as defined within.

B. Aircraft cable hanging system with easy lightweight mechanical adjustment system shall not be used for hanging HVAC and other mechanical applications.

C. Supports, bar / angle reinforcements, and other products that are not part of the duct that are manufactured of uncoated mild steel shall either be painted with two coats of primer or shall be manufactured of a galvanized equivalent material.

D. Hanger spacing not to exceed 8 feet.

2.23 FABRICATION

A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA “HVAC Duct Construction Standards Metal and Flexible” 2005 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, state and federal code requirements.

B. Ducts shall be neatly finished on the outside with all sharp edges removed.

C. Inside surfaces shall be smooth with no projections into the air stream except where otherwise indicated.

D. Transverse joints shall be made airtight with all laps in the directions of air flow.

E. All fasteners and attachments shall be made of the same material as the ducts.

F. Furnish test wells 12" on the center horizontally and vertically in the suction and discharge duct of each fan. Test wells shall consist of a 1" x 3/4", 125 lb., bronze, screwed hex bushing, secured to the duct with a bronze hex locknut on the inside of the duct. A 3/4" x 2" long standard weight bronze, screwed nipple and cap shall be fitted to the housing on the outside of the duct. Test wells shall be no. 699 as made by Ventlok or approved equal.

G. Make all changes in direction using 1.5 radius elbows where possible. Use splitter vanes or mitered rectangular elbows with turning vanes otherwise.

1. Use single thickness splitter vanes for all radius elbows less than 1.5 D = r.
   a. D = diameter of duct or width of duct (in plane of change-in-direction).
   b. r = radius of duct at duct center-line.
   c. Use “Curve Ratios” of 0.45 or greater (as defined by figure 3-7 of the 1989 ASHRAE Fundamentals Handbook).
2. Use single thickness turning vanes with no trailing edges in accordance with SMACNA Standards.
   a. All mitered, rectangular elbows in series.
   b. All mitered, rectangular elbows less than 36” in width (in plane of change-of-direction).
3. Use double width, airfoil type turning vanes with no trailing edges for all, rectangular elbows greater than 36” in width (in plane of change-of-direction).
   a. Isolated elbows have a minimum of 3D straight duct upstream and downstream of the change-in-direction.

H. Fabricate transition elbows with turning vanes at correct angle so entering and leaving edges are parallel or tangent to air flow.

I. All square elbows shall have factory-designed and built turning vanes with hollow vanes having different inside and outside curvature, similar to Tuttle and Bailey, Inc., "Ducturns". Shop fabrication vanes will not be approved. Where turning vanes are in conflict with the access doors to fire dampers. They shall be made movable, so that fire dampers shall be accessible.

J. All branch duct take-offs shall use 45° laterals or 45° “pants-leg” type fittings.

K. Dissimilar metals shall be connected with flanged joints made up with fiber or neoprene gaskets to prevent contact between dissimilar metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same materials as the gaskets. Where an aluminum duct is to be connected to a galvanized steel duct, the end of the galvanized steel duct shall be coated with heavy black asphaltum paint before connecting it to the aluminum duct.

L. Changes in shape and dimension shall conform to the following: Except where otherwise noted, for increases, in cross-sectional area, the shape of the transformation shall not exceed 1" in 7". Except where otherwise noted, for reductions in area, the slope shall not be less than 1" in 4" but 1" in 7" preferred.

M. Wherever it may be necessary to make provisions for vertical hangers of the ceiling construction passing through ducts, provide streamlined shaped sleeves around such ceiling construction hangers as to fully protect the duct from being punched with holes for the passage of such hangers. Any such streamlined sleeves shall be made air tight at top and bottom of ducts. In no case shall there be more than two rods in any 9 sq. ft. area. No rods shall pierce ducts smaller than 12" in horizontal area.

N. Fastener material shall match duct material.

2.24 DUCT CONSTRUCTION SCHEDULE

	Material	Gauge	Joints	Pressure Class	Seal Class
Rectangular supply air duct upstream of VAV	Galv.	SMACNA	SMACNA	10”	A
Round and oval supply air duct upstream of VAV	Galv	SMACNA	SMACNA	10”	A

	Material	Gauge	Joints	Pressure Class	Seal Class
Supply air duct downstream of VAV	Galv	SMACNA	SMACNA	2”	A
Round and oval supply air duct downstream of VAV	Galv	SMACNA	SMACNA	2”	A
Return air duct	Galv	SMACNA	SMACNA	-4”	A
Rectangular constant volume supply duct	Galv	SMACNA	SMACNA	6”	A
Outside air duct	Aluminum	SMACNA	SMACNA	2”	A
General Exhaust	Galv	SMACNA	SMACNA	-4”	A
Toilet exhaust	Galv	SMACNA	SMACNA	-4”	A
Kitchen Exhaust	Black iron	10	Welded	-10”	N/A
Uninsulated exterior duct. Unless otherwise identified or SST	Alum	SMACNA, Min. 22 Ga.	SMACNA	6”, -6”	A
Shower exhaust duct	Aluminum	SMACNA	SMACNA Watertight	4”	A
Dishwasher,	Stainless	SMACNA	Welded	4”	N/A
Exterior exhaust duct unless SST	Aluminum	SMACNA	SMACNA Watertight	-6”	A

2.25 FIRE DAMPERS

A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.

C. Minimum requirements for fire dampers:

1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer’s UL test installation.
2. Submit manufacturer’s installation instructions conforming to UL rating test.

2.26 SMOKE DAMPERS

A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.l13 inch W.G.).

B. Maximum air leakage, closed damper: 0.32 cubic meters/min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.

C. Minimum requirements for dampers:

1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
3. Blades; Galvanized steel, parallel type preferable, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
4. Shafts: Galvanized steel.
5. Bearings: Nylon, bronze sleeve or ball type.
6. Hardware: Zinc plated.
7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.

D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.27 COMBINATION FIRE AND SMOKE DAMPER

A. Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

2.28 INSTRUMENT TEST FITTINGS

A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.

B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine location where ductwork is to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DUCTWORK

A. Assemble and install ductwork in accordance with recognized industry practices, which will achieve air-tight and noiseless systems, capable of performing each indicated service.

B. Duct sizes shown on the Drawings at connection to fans or other equipment may vary in actual installation. Contractor shall provide transition pieces as required.

C. Fittings shall be configured to provide the least possible pressure drop.

D. Install each run with a minimum of joints.

E. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

F. Support ducts rigidly with suitable ties, braces, hangers and anchors of the type, which will hold ducts true-to-shape to prevent buckling. Supports shall be placed at each joint and change in direction up to a maximum spacing of 8

feet on centers.

G. Seal ducts in accordance with SMACNA requirements for pressure class indicated.

1. Indoor Ducts: Use liquid or mastic sealant, or tape system.
2. Outdoor Ducts: Use tape system.
3. Approved manufactured joining systems with gaskets may be used in lieu of transverse sealing.

H. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Casing and hangers shall be installed straight and level and all shall be free of vibration and noise when fans are operating.

I. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building.

1. Limit clearance to 0.5” where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
2. Where possible, locate insulated ductwork for 1.0” clearance outside of insulation.

J. Ducts at ceilings shall be suspended from inserts in concrete slabs except where otherwise indicated. Inserts shall be Grinnel Fig. 279, 282, or 152 as required. Each duct shall be independently supported and shall not be hung from or supported by another duct, pipe, conduit or equipment of any trade. Duct hung below slabs less than 4” thick shall be supported from supplemental steel.

K. All fastenings to building structure shall be adequate to insure permanent stability of sheet metal work and shall be capable of resisting all applied forces.

L. Vertical ducts in shafts or passing through floors shall be supported by steel angles or channels, welded, riveted, screwed or bolted to ducts and fastened to building structural members at each floor level. Provide safeing to close all floor openings around ductwork - pack annular space with rockwool and 18 gauge sheet metal safeing. Floor openings in plenums shall have 1/2 inch diameter steel bars constructed in a 6”x6” grid.

M. Rigid connections between ductwork and non-rotating equipment shall be 12 inch on centers and shall be made with flanged joints, sealed with fireproof material (Fiber or Neoprene gaskets).

N. In finished spaces, conceal ductwork by locating in mechanical shafts, hollow wall construction or above suspended ceilings.

O. Where possible, avoid locating ducts on or near floor.

1. Where ducts must be located low, provide metal trestle to protect duct at places where duct will be climbed over.
2. Ducts at floor shall be supported by steel angles suitably anchored to floor construction.

P. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work as well as other components of systems.

Q. Install access doors where necessary for inspection and maintenance.

1. Provide additional 12” x 12” access door at each low leakage damper.
2. Arrange access doors so that:
   a. They open against the system air pressure wherever feasible.
   b. Their latches are operable from either side, except where the duct is too small to be entered.

R. Where ducts pass through non-fire-rated interior partitions below ceiling and exterior walls:

1. Conceal the space between the construction opening and the duct or duct-plus-insulation with sheet metal flanges of the same gauge as the duct.
2. Overlap the opening on all sides by at least 1-1½".

S. Provide volume dampers at all branch take-offs.

T. Provide conical or tapered taps with balancing dampers on all round ductwork takeoffs.

U. Where space permits, round or oval ductwork of equivalent diameter may be substituted for unlined rectangular ductwork.

V. Provide 22-gauge aluminum ductwork for the first 20 feet downstream of any aluminum grille. Slope duct towards grille at 1/8" /ft.

W. It is the intent to obtain ductwork construction with minimum leakage. The construction noted in Specifications can produce low or high leakage rates, depending upon the workmanship, particularly with regard to the connection at the top of the ducts. Guarantee that total diffuser volume, measured by means of velometer, shall be at least 95% of actual fan supply (measured by means of a duct traverse tank with a Pitot tube and water manometer). Seal the ductwork at joints with suitable sealers Ductmate PROseal sealant and tape. Use of "HARDCAST" or any other material is subject to Architect's approval.

X. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.

Y. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.

Z. Construct casing, eliminators, and pipe penetrations in accordance with SMACNA Standards.

AA. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.

BB. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.

CC. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.

DD. Temperature range: -18 to 93 degrees C (0 to 20 degrees F) internal.

EE. Maximum working velocity: 1200 m/min (4000 feet per minute)

FF. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.

GG. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

HH. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 4 feet long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated on hour or two hour. Support ducts SMACNA Standards.

II. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.

JJ. Control Damper Installation:

1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

KK. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.

3.3 DUCT HANGERS

A. Low pressure ducts up to 24" on a side or up to 20" diameter shall be suspended with 16 gauge, galvanized strap hangers, 1" wide.

B. Low pressure ducts 25" to 40" on a side or 21" to 40" diameter shall be suspended with galvanized strap hangers 1" wide by 1/8" thick.

C. Strap hangers shall be bent 90˚, extended down sides of ducts and turned under bottom of ducts a minimum of 2". Strap hangers shall be fastened at ceiling with nuts, bolts and lock washers and to sides and bottom of ducts with sheet metal screws.

D. Rod type hangers shall be 3/8" diameter black steel rods threaded at both ends and bottom bracing angles on ducts, with nuts and lock washers.

E. Angle type hangers shall be extensions of side bracing angles on ducts, bent 90 at ceiling and fastened with nuts, bolts and lock washers.

F. Hangers for vertical ducts shall be as per SMACNA Duct Manual.

G. Stainless steel ductwork shall be supported with rod or angle type hangers, so that there will be no penetration of the stainless steel ducts.

H. Provide supplemental steel to span structure in areas where duct cannot be otherwise supported from primary structure.

I. Do not support ductwork from pipe, other ducts, ceiling system, metal deck, metal roof deck or furring.

J. Do not hang lighting or pipes from ductwork.

K. Do not use perforated hanger straps to support ductwork.

3.4 GREASE EXHAUST DUCTS

A. Install in accordance with Local Building Code and NFPA 96. Connect to hoods in accordance with the manufacturer's listing.

B. Horizontal duct less than 75 feet in one run shall be pitched at ¼" per foot towards the hood or a drain point. Those portions over 75 feet shall be pitched at 1" per foot.

C. Enclose entire run of grease duct from hood to exterior wall or roof curb in fire barrier system. See detailed requirements elsewhere in this section and Insulation Section.

1. Install duct so a minimum of 6" and a maximum of 12" is maintained between duct and enclosure.

D. Use no turning vanes, tie rods, dampers or other internal structures which will collect grease. All changes in direction shall be made with radius fittings.

E. Provide cleanouts as follows:

1. Cleanouts shall be installed in the side or top of the duct, whichever is more accessible.
2. When installed on the side, the bottom of the opening shall be a minimum of 1-1½" above the bottom of the duct.
3. Ducts serving hoods with integral fire dampers shall have a clean out opening with in 18" of the collar.
4. Horizontal ducts shall either have one opening large enough for personnel entrance or at 12' intervals.
5. Vertical ducts shall either have one opening at the top large enough for personnel entrance and descent or a minimum 12" x 12" openings at every floor.
6. Openings shall have a flanged frame, extending 1" off the ductwall. Closure panels shall be attached to the flange by means of threaded studs welded to the flange, protruding through holes in the panel and fastened by means of wing nuts. Provide "Fiber Frax" or equivalent high temperature (1500°F) rope type gasket bonded to either the gasket or panel.
7. Provide access doors in the enclosure at all cleanouts.
   a. Use UL listed methods for blanket type fire rated enclosures.
   b. Use UL listed fire rated access doors in shaft wall enclosures.
8. Provide access doors at each change in direction.

3.5 DRYER EXHAUST DUCT

A. Assemble duct with no sheet metal screws, and no protrusions into the duct. All interior surfaces are to be smooth.

B. All elbows are to be radius type.

C. Ducts, which pass through fire rated walls, must be enclosed in a rated enclosure. Fire dampers are not allowed.

D. Provide interlocked exhaust fan where developed length of duct exceeds U.L. Listing of dryer(s).

3.6 DUCT LEAKAGE TESTING

A. Installed ductwork shall be pretested prior to installation of access doors, take-offs, etc.

B. All leak testing shall be witnessed by the Engineer or representative of the Engineer. The Contractor shall give the Engineer 72 hours notice prior to testing. Any testing not witnessed by the Engineer or his/her representative, shall be considered invalid and will be redone.

C. Test the ductwork leakage for each system (air handler, exhaust fan, return fan, etc.) and totalize leakage on a per system basis.

D. Use the leakage formula from section 4 of the SMACNA HVAC Air Duct Leakage Testing Manual, 1st edition, for calculating the allowable leakage for each section of ductwork based on the leakage classifications listed below:

1. Pressure classification 4" and over- Leakage Class 6
2. Pressure classification 3" - Leakage Class 12
3. Pressure classification 2" - Leakage Class 24

E. All volume dampers, fire and fire smoke dampers, and duct access doors shall be installed prior to the testing; no additional leakage rates will be allowed for these components. In-duct coils and VAV boxes are not to be included in the leakage testing.

F. Provide summary reports for each system on a single table which list each section tested, surface area of tested section, allowable leakage, and measure leakage. Include the measured velocity pressure from the testing rig and a legible copy of the nomegraph used to determine the actual flowrate.

G. The final testing shall be performed as follows:

1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
2. Use a certified orifice tube for measuring the leakage.
3. Define section of system to be tested and blank off.
4. Determine the percentage of the system being tested.
5. Using the percentage, determine the allowable leakage (cfm) for that section being tested.
6. Pressurize to 1.5 times operating pressure and repair any significant or audible leaks.
7. Repressurize and measure leakage.
8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

NOTE: It is recommended that the first 100'-300' of ductwork installed be tested to insure the quality of the workmanship at an early stage.

H. All transverse joints and longitudinal seams shall conform to SMACNA's Class A sealing requirements.

I. Constant Volume Systems/Supply Ductwork
Allowable Leakage 1% of design cfm

J. Constant Volume Systems/Return Ductwork
Allowable Leakage 2% of design cfm

K. Variable Air Volume Systems/Supply Ductwork
Fan to VAV Boxes 1% of design cfm
VAV Boxes to Registers 2% of design cfm

L. Variable Air Volume Systems/Return Ductwork
Allowable Leakage 2% of design cfm

M. Exhaust Systems 2% of design cfm

3.7 GREASE DUCT LEAKAGE TESTING

A. The test shall be performed prior to the concealment of any part of the system.

B. The grease duct shall be tested via a light test or an approved equivalent test, to confirm all joints are liquid tight. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of duct work to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls.

C. Any joint where light can be seen from outside the duct shall be considered a defect. All defects shall be corrected, and the system shall be retested until no defects are found.

D. Test shall be performed for the entire grease duct system, including the hood-to-duct connections. The test may be performed on sections of duct, provided that each joint in the system is tested.

E. The contractor shall be responsible for providing the necessary equipment for performing the leakage test as described.

3.8 DUCTWORK STORAGE AND CLEANING

A. Cleaning:

1. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris.
2. Clean external surfaces of foreign substances which might cause corrosion of metal or deterioration of paint.

B. Protection:

1. Store duct a minimum of 4" above ground or floor to avoid damage from weather or spills.
2. When internally cleaning duct work prior to installation or shipment to the jobsite, all duct ends and openings must be covered prior to transporting with a dual Polyethylene protective film. Film must be securely affixed to protect against dirt and debris and must be translucent to facilitate inspection of interior surfaces without removing film. Film must have a minimum elongation of 600%, contain no VOC and leave no residue on duct after removal. Approved Manufacturer: Ductmate Industries ProGuard or approved equal.
3. Cleaning of new and existing supply ductwork in existing buildings. After completion of ductwork installation purge ductwork as follows:

    a. Cover all supply registers and diffusers with oil cheese cloth.
    b. Use supply fan and install temporary fan to provide air to the system for twelve (12) hours at 200% design flow.
    c. Remove oil cheese cloth.

C. Ductwork contaminated or damaged above "shop" or "mill" conditions shall be cleaned, repaired or replaced to the Engineer's satisfaction.

1. Ductliner pre-installed in stored duct which has become wet may be installed if first allowed to completely dry out.
2. Ductliner in installed ductwork, which has become wet must be completely removed and replaced.
3. Torn ductliner may be replaced by coating with adhesive if damaged is minor and isolated. Extensively damaged liner shall be replaced back to a straight cut joint.

3.9 ACCESS DOORS

A. Install access doors where necessary for inspection, adjustment or servicing. In no case shall access to any items of equipment requiring inspection, adjustment, or servicing require the removal of nuts, bolts, screws, wing nuts, wedges, or any other screwed or loose device. Access doors shall be minimum 18"x 18" unless duct size requires a smaller door.

B. Arrange access doors so that:

1. They open against the system air pressure, wherever feasible.
2. Their latches are operable from either side, except where the duct is too small to be entered.

C. Provide access doors as follows:

1. Downstream and upstream side of coils within 3'-0" of coil.
2. Upstream and downstream of each humidifier.
3. Every 50’ along length of duct requiring cleaning.
4. At each automatically controlled damper, fire damper, smoke damper or fire/smoke damper.
5. In paint spray booth exhaust, provide access door at each sprinkler head.
6. Every 12” along length of kitchen exhaust duct.
7. On actuator side of each motorized damper.
8. At the base of all risers.
9. At all intake plenums.
10. At all smoke detectors.
11. At all valves, controls, filters, bearings, traps, drains, etc.

D. Hinges shall be Ventlok No. 150 or 260 with or without screw holes or approved equal. Latch for walk-in access doors shall be No. 260 as made by Ventlok Co. or approved equal. Latch for access door in ductwork shall be Ventlok No. 100 or approved equal.

E. Provide 4” high and 4” wide concrete pad all around opening at duct penetrations thru floors. Fill in space between duct and floor construction with mineral wool and fire rated sealant.

END OF SECTION

SECTION 23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) latest recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data on the following:

1. Flexible duct
2. Ceiling dampers
3. Fire dampers
4. Smoke dampers
5. Louvers
6. Lint Collector

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT ACOUSTICAL

A. Manufacturers:

1. Flexmaster Type 8M, or approved equal.

B. Construction:

1. CPE Liner film mechanically locked without adhesives.
2. Insulation: Minimum 1-½" thick fiberglass blanket with a polyethylene vapor barrier. Map 0.23 'c' factor, factory installed.
3. Helix: Corrosion resistant galvanized steel.

C. Pressure rating: 6" w.g. positive, 1" w.g. negative at maximum 180°F operating temperature.

D. Standards: NFPA90A UL-181, Class I, ASTM E-96 - Procedure A.

E. Insertion loss shall be at least:

	OCTIVE BAND (Hz)					
Duct Size	125	230	400	1000	2000	4000
6"	7	31	40	38	40	27
8"	13	29	36	35	38	22
12"	21	28	29	33	26	12
	DB reduction for 10 foot length tested in accordance with ASCME 477.					

2.2 FLEXIBLE DUCT, HIGH PRESSURE

A. Manufacturers:

1. Design Basis: Flexmaster Type 3
2. Other Acceptable Manufacturers:
   a. Thermaflex, MKC
   b. Genflex, IGE
   c. American/Elgen

B. Construction:

1. Insulated: Reinforced inner liner, mechanically locked or bonded together by a corrosive resistant galvanized steel helix, Min. 1-½" thick fiberglass blanket with polyethylene vapor barrier. Max. 0.23 'c' factor.
2. Uninsulated: Mechanically locked without adhesives with a corrosion resistant galvanized steel helix.
3. Aluminum: Mechanical lock without adhesives.

C. Pressure rating: 12" w.g. positive, 1" w.g. negative at 180^0F.

D. Standards: NFPA90A, UL-181 Class I, ASTM E96 - Procedure A.

2.3 FLEXIBLE RUN-OUTS

A. The run-outs from medium or high pressure duct to terminal units such as Variable air Volume or Constant Air Volume boxes, induction units, or air mixing boxes may be flexible duct.

B. Flexible metal duct shall be all-metal, boundable, self-supporting and mechanically interlocked to be totally leak proof under operating conditions without manufacturing use of adhesives.

C. Flexible ducts shall be type AL006 uninsulated or Type AL006-150 insulated as made by United Sheet Metal or approved equal. The flexible run-outs shall take all bends without kinking. The run-outs shall be flame resistant, shall have a low friction loss, and shall have working pressure minimum off 10 inch W.G. Flexible run-outs shall be no longer than 5'-0" and shall comply with Local Union Requirements. Any additional lengths necessary to connect the flexible duct to the high or medium pressure ductwork shall be made with spiral lockseam sheet metal duct of the same size as the flexible ductwork.

D. The flexible run-out duct shall meet all requirements of the National Fire Protection Association 90A - Latest Edition. Flame spread not over 25, smoke developed not over 50.

E. Each flexible run-out duct shall be sealed to its male outlets on both ends with 3M EC-800 sealer, or sealing compound as recommended by the flexible air duct manufacturer. The flexible air duct shall be sealed and covered to a minimum depth of 2 inches of its mating metal coupling, branch take-off lap or duct at each of its ends. A Wraplock Ideal No. 5900 Strap-Clamp shall be furnished and installed at each end of the flexible duct.

F. Complete installation shall be airtight.

2.4 LOUVERS

A. Louvers are specified in the Architectural Division. This division is responsible for coordinating all duct connections, damper sizes, etc. with the louvers specified. Where a louver is required, but none is specified by the Architect, a louver meeting the requirements detailed below shall be provided.

B. Where Louvers are not specified by the architect, provide the following.

1. Manufacturers:

a. Design Basis: Greenheck
b. Other Acceptable Manufacturers:
1) Arrow
2) Pottorff
3) Moore
4) Ruskin
5) United Air

2. Screens: ½" mesh, .063" aluminum wire.

3. Blades: Of depth shown by schedule, drainable.

4. Rating Basis:

a. AMCA Standard 500, based on 15 minute test of 48" x 48" louver. Provide louvers with water penetration and pressure drop no greater than specified louver, and with free area no less than specified louver.
b. Manufacturer shall provide test data under actual performance conditions to support the published performance data upon request by engineer or architect.

2.5 PREFABRICATED CURBS

A. General: Except where curbs are provided with equipment, provide prefabricated curbs for all roof mounted equipment.

B. Manufacturers:

1. Design Basis: Pace
2. Other Acceptable Manufacturers:
a. Thycurb

C. Model for grease-laden exhaust fans: ES-2.

1. Coordinate to fit vibration isolation rail.

D. Coordinate with roofing Contractor. Exterior insulation, cants, flashing and counter flashing shall be furnished and installed under roofing work, Division 7.

E. Model: As required.

F. Roof Curbs

1. Roof curbs shall have a minimum height of 14" or as specified on the drawings, whichever is greater.
2. Roof curb insulation shall match the insulation requirements of the ductwork.
3. Roof curbs for kitchen exhaust ductwork shall include vented curb extension similar to Greenheck model VCE.

2.6 INSULATING AND SOUND REDUCING DUCT LINING FOR LOW PRESSURE DUCTWORK

A. Furnish and install all soundproofing material specified, indicated or necessary to that all systems will comply with requirement of quiet operation. In general, noise level in any part of building (except in machinery rooms), due to air conditioning or ventilating equipment, ducts, and outlets, shall not exceed 40 decibels at 1200-2400 cycles per second, except as otherwise hereinafter specified.

B. Furnish and install sound-absorptive lining in ductwork for locations and lengths as indicated and/or hereinafter specified. All soundproofing material, installation and arrangement, shall be as approved. Where ducts are acoustically lined, insulation shall be omitted for extent of acoustic lining. Dimensions noted for lined ducts are inside clear dimensions. Duct sizes shall be increased for liner.

C. Sound Absorbent Duct Lining for Low Pressure Ductwork - furnish and install as herein specified and/or shown on the drawings (except where otherwise noted) 1-1/2 lb. density, fibrous glass or polyester duct lining meeting the requirements of NFPA 90A.

1. 1" thick when installed in conditioned space
2. 1.5” thick, R-6 when installed in unconditioned space
3. 2” thick, R-8 when installed outside.

D. Liner shall be adhered to all interior sides of duct with minimum 100% coverage of fire-retardant adhesive similar to Benjamin Foster4 or PROtack spray by Ductmate Industries and with weld pins and washers or equivalent mechanical fastening starting 3" from edges and sides, 12" on center all sides. Minimum one row per side for duct size of 12" or less. Mechanical fasteners shall cause quilting of surface. Coated surface or FSK facing shall be toward air stream. Before installing liner, seal all butting edges and final edges with heavy coat of adhesive to seal off air between lining and duct. All exposed edges of lining shall be installed with sheet metal nosing 1-1/2" wide, two gauges heavier than duct. Installation shall be suitable for duct velocities up to 5,000 fpm. Low pressure duct lining shall be provided where specified and/or where shown and noted on the drawings. Liner support pins on aluminum duct shall be riveted to duct wall with closed end rivits.

E. Duct sizes indicated on drawings are clear inside dimensions. Increase sheet metal sizes as required to install acoustic lining.

F. The following ductwork shall be acoustically lined whether or not shown on Drawings.

1. Ductwork 15’ downstream of mixing box and terminal units.
2. Single wall built-up casing walls and ceiling except that lining shall be 2" thick 4 lb. density, and inner liner of perforated galvanized sheet metal (7/64" dia. holes on 3/16" staggered centers) shall be used for all systems.
3. All supply air ductwork within 25' of fan discharge.
4. All return air ductwork within 25' of fan intake.
5. All exhaust ductwork within 20' of fan intake.
6. Return air fan and toilet exhaust plenum walls and ceiling, except lining shall be 2 inch thick 4 lb. density, and inner liner of perforated galvanized sheet metal (7/64" dia. holes on 3/16" staggered centers) shall be used.
7. Outside air duct to air handling units.
8. All supply, return and exhaust ductwork installed exposed to conditioned space.

G. All ductwork not indicated to be lined shall be externally insulated.

2.7 ACOUSTICAL PERFORMANCE SPECIFICATIONS - GENERAL

A. It is the intent of this Specification that noise levels due to air conditioning and/or ventilating equipment, ducts, grilles and registers, diffusers and air light fixtures, will permit attaining sound pressure levels in occupied spaces conforming to the following NC curves as explained in the ASHRAE Guide and Data Book.

Classrooms	NC-25
Office and Conference Rooms	NC-30
Lobby	NC-35
Hotel Room & Suites	NC-25

B. Grilles, Registers, Diffusers

1. The maximum permissible sound power levels of air terminal devices when installed and operating per plans and specifications shall be as follows:

	Maximum PWL re 10-12 Watts		
Octave Band	NC-30	NC-35	NC-40
1	62	64	66
2	52	56	60
3	44	49	54
4	41	46	51
5	38	43	48
6	37	42	47
7	36	41	46
8	37	42	47

C. Sound Power Levels shall be tested in accordance with ASHRAE Standard 6=36-72.

2.8 ACOUSTICAL PERFORMANCE WITHIN EQUIPMENT SPACES

A. Equipment room noise levels and noise transmission to adjacent buildings shall comply with all Federal, State, and City Noise Ordinances.

B. Motor Acoustical Performance:

1. Motor drives for pumps and refrigerator machine when installed per plans and specifications shall operate with noise levels not to exceed 80 decibels.

2. Noise levels shall be determined in accordance with IEEE Standard #85 test "procedure for Air-Borne Noise Measurements on Rotating Electric Equipment".

2.9 BALANCING DAMPERS

A. At each main branch take-off and in such other locations where required to properly balance the low pressure system, furnish and install volume dampers of the opposed blade, multi-louvered type, which shall be operated by indicating quadrants and set screws, for adjusting the system.

B. Volume dampers shall be constructed as follows: Damper blades shall not be wider than 12", shall be complete with heavy angle iron frames, connecting and operating links, brass trunnions, and bronze bearings. Dampers, unless otherwise noted, shall be fabricated with not less than No. 16 gauge sheet steel. Blades shall overlap and shall be provided with continuous stops on all four sides of dampers to prevent leakage. Blades shall be galvanized. Blades of dampers shall be set into a flat steel frame with frame securely bolted to the duct. All dampers shall be fitted with a hexagonal brass spindle which shall extend through the exterior of duct and be fitted with an indicating self-locking regulator. Regulator shall be similar to Ventlok 641 or approved equal. All hardware shall be Ventlock or approved equal. For insulated ductwork provide No. 644 self-locking regulator as made by Ventlok or approved equal.

C. Maximum of two blades without a frame: Over two blades, use a manufactured 16 gauge galvanized stiffened, opposed blade damper in a 14 gauge galvanized steel frame. All hardware shall be galvanized except bronze iolite bearings; Pottorff Model MD-42 or approved equal.

D. All automatic dampers shall be furnished as a part of the automatic temperature control system by the automatic temperature control manufacturer. Install dampers and provide safeing in ductwork for automatic dampers smaller than duct size.

E. Movable splitter dampers shall be provided at each and every supply take-off and wherever else indicated. Dampers shall be airfoil, double-wall type. Splitter damper assembly shall be Ventlok 603 Ball Joint Bracket and 600 Blade Bracket or approved equal. All hardware shall be Ventlok or approved equal. Blades to be spot welded or pivoted to shafts. Elevated regulators shall be provided for insulated ductwork.

F. For stainless steel and aluminum ductwork provide dampers of same material as ductwork.

G. All dampers shall be made accessible from building construction. Access doors in building structure shall be furnished or provided as herein before specified.

H. Maximum pressure drop in full open position (@3000 fpm): 0.55

I. Maximum leakage: 32 cfm/sf at 4" W.C.

J. Provide cable operated dampers for all balancing dampers located above hard/inaccessible ceilings. Manufactured by Young Regulator or approved equal. Termination options are subject to Architect's approval.

2.10 FIRE DAMPERS

A. Manufacturers:

1. Design Basis: Ruskin
2. Other Acceptable Manufacturers:
   a. Prefco
   b. Air Balance
   c. Safe-Air
   d. United Air
   e. United Sheetmetal
   f. National Controlled Air
   g. Air Control Products
   h. Greenheck

B. Rating: UL555 dynamic 1-½ hours (2 hour wall), or 3 hours (3 or 4 hour wall), UL555S Class II leakage rated. Match construction penetrated. FM approved.

C. Size: Metal-to-metal for lined and unlined ducts.

D. Fusible link only. Use Type B "Top Hat" wherever possible.

E. Clearly indicate fire damper location on shop drawings. Provide access doors in the ducts and furnish access doors or panels at building construction at each damper of sufficient size and type to permit inspection and replacement of linkage. Assume responsibility to coordinate all locations of duct access doors with the General Contractor to conform with whatever architectural openings may be necessary and furnish access doors or panels in building construction. Provide shop drawings indicating location of access panels or doors for Architect's approval.

F. It is the intention of these plans and specifications to be complete. However, it is the responsibility of this Division, as being completely cognizant of local regulations, to determine where fire dampers are required and to advise the Architect prior to bid as to any discrepancies or questions in the plans or specifications.

G. Fire dampers shall be enclosed in integral UL/FM approved sleeve of fourteen gauge metal set and grouted into fire partitions. Sleeve shall be secured at both sides of fire partitions with 1-1/2 x 1-1/2 x 1/4 ga. mounting angles secured to sleeves only. Provide duct breakaway connections, see detail on drawings. Sleeves shall be continuously welded with the transverse joint sealed. Flanged duct/sleeve connection shall be UL listed.

H. Dampers shall be steel plate, mounted to turn freely, in steelplate frame inserted in duct. Dampers shall be proportioned and weighted to close at once, if released from link with spring catches to hold closed, until manually reset. Dampers and frames to have suitable eyes, standard fusible-links, normally holding them open, but releasing upon contact with fire. Damper blades shall be mounted on corrosion resisting bearings. Damper shall close by gravity, moving with the air stream to full closed position against one-eighth (1/8) inch angle stop. Steel spring catch shall hold damper closed. Radius arm on shaft shall show position of damper. Submit details for approval. Dampers shall be outside of air stream where space permits.

I. In stainless steel ductwork, provide stainless steel construction fire dampers similar to Fire Seal Model 119D.

2.11 FIRE/SMOKE DAMPERS AND DAMPER OPERATORS

A. Manufacturers:

1. Design Basis: Ruskin
2. Other Acceptable Manufacturers:
   a. National Controlled Air
   b. Johnson Controls
   c. Safe Air
   d. Prefco
   e. Air Balance
   f. Greenheck

B. Fire Damper Rating: UL Standard 555 Dynamic, 1-½ hour or 3 hours. FM approved.

C. Smoke Damper Rating: UL Standard 555S, Class II.

D. Each combination fire/smoke damper shall be 1-1/2 or 3 hour fire rated under UL Standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class 2 (10 cfm/ft. at 1" w.g.).

E. Jackshaft penetrations shall be provided with a factory installed shaft seal, field sealing of the shaft is not acceptable.

F. Damper Assembly:

1. Type: 120 volt.
2. Listing: UL 555S, UL555.
3. Rating: Match wall rating.
4. Failure Position: Fail closed.
5. Fusible Link: 165°F fusible link.

6. Blade: Air foil.
7. Seals: Mechanically fastened, rated up to 450°F.
8. Smoke Detector: Duct mounted within 4' of damper. Activation of detector shall close damper and alarm fire alarm system.

G. Where part of Smoke Control System.

1. Provide end switch for positive indication of damper position.
2. Provide means to re-open damper remotely in the event thermal link trips. Allow for re-open up to elevated rating of 350°F, after which the elevated temperature high-limit override shall close the damper.

H. Combination fire/smoke dampers shall meet or exceed the following specifications. Frame shall be a minimum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. The blades shall be airfoil shaped double skin construction with 14 gage equivalent thickness. Blade edge seals shall be silicone rubber designed to withstand 450˚F and jamb seals shall be stainless steel flexible metal compression type. Blade action must be parallel blade or opposed as required.

I. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position, and 2000 fpm air velocity in the open position.

J. In addition to the leakage ratings already specified herein, the combination fire smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250˚F, 350˚F, or 450˚F depending upon the operator. Appropriate electric operators shall be installed by the damper manufacturer at time of damper fabrication. Damper and operator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer shall provide factory assembled sleeve of 16" minimum length (contractor to verify requirement). Sleeve shall be 20 gage for dampers through 36" x 48" and 18 gage above 36" x 48". Sleeve shall be continuously welded or sealed and the transverse joint shall be sealed. Flanged duct sleeve connection shall be UL approved. Damper and operator assembly shall be factory cycled 10 times to assure operation.

K. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat equal to Ruskin model TS150. Firestat shall electrically and mechanically lock damper in a closed position when duct temperatures exceed 212˚F and still allow appropriate authority to override Firestat and operate damper as may be required for smoke control functions. Damper must be operable while temperature is above 250˚F. Firestat package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when damper is fully open; the other switch shall close when the damper is fully closed. Firestat and position indicator switches shall be capable of interfacing electrically with smoke detectors, building fire alarm systems, and remote indicating/control stations. Provide damper test switch and remote annunciation indicator. Dampers shall be Ruskin Model FSD36 with TS150 Firestat package.

L. Provide 3-function actuators where dampers are used to modulate air flow during normal operation.
1. Fire function
2. Smoke function
3. Modulating position control function

2.12 SMOKE DAMPERS

A. Manufacturers:

1. Design Basis: Ruskin
2. Other Acceptable Manufacturers:

a. Air Balance
b. Greenheck
c. Johnson Controls
d. National Controlled Air
e. Pottorff
f. Prefco
g. Safe Air

B. Smoke Damper Rating: UL Standard 555S, Class II.

C. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in Smoke Control Systems under the latest version of UL555S, and shall bear a UL label attesting to same, as (Class II Rating). Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class II (10 cfm/ft. at 1" w.g.).

D. Operator:

1. Type: 120 volt.
2. Listing: UL Smoke Damper Operator Label.
3. Failure Position:
   a. Smoke control system dampers: As shown on plans.
   b. Others: Closed
4. Smoke Detector: Duct mounted within 4' of damper. Activation of detector shall close damper and alarm fire alarm system.

E. Blade: Air foil.

F. Seals: Steel.

G. Where part of smoke control system:

1. Provide end switches for positive indication of damper position, open and closed.

H. Furnish and install at locations indicated on plans, or as described in schedules, or as required by applicable codes, smoke dampers meeting or exceeding the following specifications. Frame shall be aluminum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. The blades shall be single skin 16 gage minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450˚F and jamb seal shall be stainless steel flexible metal compression type.

I. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position, and 3500 fpm air velocity in the open position for normal operation.

J. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350˚F. Electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. Dampers shall be Ruskin Model SD36 or approved equal.

K. Each smoke damper shall be equipped with Ruskin SP100 Switch Package or equal. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

L. Provide 3-function actuators where dampers are used to modulate air flow during normal operation.

1. Fire function
2. Smoke function
3. Modulating position control function

2.13 LINT COLLECTOR

A. Manufacturers:

1. Design Basis: LFSystems Model ILC, or approved equal.

B. Construction:
1. 20-ga stainless steel
2. Replaceable polyester multifilament 200-micron filter bag
3. Access panel

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESSORIES

A. Install fire, smoke and ceiling dampers in accordance with manufacturer's instructions and the latest version of the Fire, Smoke and Radiation Damper Guide for HVAC Systems, published by SMACNA.

B. Use HIGH PRESSURE flexible duct where shown upstream of VAV boxes.

C. Notify fire alarm provider of smoke damper control requirements and fire alarm interlocks.

D. Install flexible ductwork without tight bends and free of kinks.

1. Flexible ductwork shall not exceed 6' in length.
2. Flexible ductwork shall be installed with a "minimum length of straight duct" upstream of the diffuser neck inlet. "A minimum length" shall mean a length equal to three (3) duct diameters. "Straight duct" shall mean the center-line of the duct shall be aligned with a line perpendicular to the plane of the diffuser neck opening at the center point of the opening.
3. Conform to the detail on the drawings.

E. Install all dampers, including those furnished by control contractor.

1. Caulk damper frames to ductwork.
2. Make sure dampers are free to operate properly.
3. Install parallel blade mixing dampers to two streams impinge on each other to facilitate mixing.

F. Provide balance dampers at all branch take-off and where required to minimize balancing performed at diffuser face.

G. Louvers shall be made easily removable without impacting finishes where access is required to service and maintain equipment installed behind.

H. Provide all balance dampers as shown on plans and any additional dampers necessary to provide a balanced system meeting all sound requirements.

I. Fire and smoke dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance. The access shall not reduce the fire-resistance rating of the assembly. Access point shall be permanently identified on the exterior by a label having letters not less than ½" in height reading: SMOKE DAMPER, FIRE DAMPER or FIRE SMOKE DAMPER.

END OF SECTION

SECTION 23 34 00

FANS

PART 1 - GENERAL

1.1 QUALITY CONTROL

A. Provide fans with AMCA performance certification and label.

B. Grease exhaust fan shall comply with NFPA 96 and be UL listed.

1.2 MOTOR HORSEPOWER

A. Do not increase or decrease motor horsepower from that specified without written approval from Architect/Engineer. See Section 23 05 01.

1.3 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's product data including:

1. Performance
2. Size
3. Type
4. Options provided
5. Fan curves
6. Indicate Compliance with Section 1.1 where applicable.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS (CLASS I)

A. Manufacturers:

1. Design Basis: As scheduled.
2. Acceptable Manufacturers:
   a. Greenheck
   b. Buffalo
   c. Trane

B. Furnish and install as shown on the plans non-power overloading centrifugal fans with airfoil blades in sizes 24 and larger and plate-type blades in sizes 22 and smaller. Fans shall be of the specified size, arrangement, class and capacity. Fans having outlet velocities greater than those shown will not be acceptable.

C. Housings of fans, Class I, having wheel diameters 36" and smaller shall be convertible for various directions of discharge. Side sheets shall be fastened to scroll sheets by means of a deep lockseam. Housing supports shall be of one-piece welded constructed. Housing for Class I fans, having wheel diameters over 36", shall have side sheets welded to scroll sheets. Housings shall be split into two or more sections with heavy flanges on each section for bolting together. Flanges joints shall be gasketed for air-tightness. Sealer shall be applied to joints between housing, inlet and housing support to prevent air leakage. The cutoff shall be of the rolled slope type and shall be wider and closer to the shaft at the suction side, then the drive side, for single width fans. Inlet collars on all sizes of single width fans shall extend beyond the fan housing to provide a continuous duct connection. Inlet collars on

convertible housings shall be round and on nonconvertible housing shall be square. Both inlet and discharge duct collars shall be drilled or punched at uniform intervals. Inlet cones shall be spun or die-formed to provide smooth air flow into the wheel with minimum shock and turbulence.

D. Fans wheels shall be constructed of twelve deep airfoil blades, plate type blade in sizes 22 and smaller, backward inclined from the direction of rotation. Blades shall be securely welded to the spun rim and hub plate. Hubs shall be of close grined cast iron, securely riveted to the hub plate. All wheels shall be carefully trued after assembly and shall be carefully trued after assembly and shall be dynamically balanced.

E. Fan shafts shall be of SAE 1040 hot rolled steel, accurately turned, ground and polished. Close tolerances shall be maintained where shaft makes contact with bearings and fan wheel hub. All fans shall have adjustable belt and drives and shall be driven by a minimum of two belts.

F. Fans shall be equipped with precision anti-friction extra heavy duty bearings of the self-aligning, grease-packed, pillow block type having a grease seal that will prevent loss of lubricant and exclude dirt from the bearings. Lubrication fittings shall be provided on exterior of cabinet or housing. Average bearing life shall be min. 200,000 hours.

G. All fans shall be given a bonding coat before painting. After the cleaning and surface conditioning process, but before assembly, parts shall be spray painted with one coat of grey primer-finisher. A second coat of the same paint shall be applied to the exterior and all accessible interior surfaces after the fan is assembled. Shafts shall have a rust-preventive coating.

H. Fan ratings shall be based upon tests performed in strict accordance with the test code adopted jointly by the Air Moving and Conditioning Association and the American Society of Heating, Refrigeration and Air Conditioning Engineers. Each fan shall carry, near the manufacturer's nameplate, the seal authorized by AMCA indicating that ratings are certified. Fans not bearing this seal will not be acceptable.

I. Fans shall be as scheduled on the Drawings.

J. Provide 2" wire mesh inlet screens with each fan.

2.2 IN-LINE CENTRIFUGAL FAN

A. Manufacturers:

1. Design Basis: As scheduled
2. Acceptable Manufacturers:
   a. Greenheck
   b. Cook
   c. Trane
   d. Aerovent
   e. Carrier
   f. Jenn Air
   g. Penn
   h. American Coolair
   i. Powerline
   j. Twin City
   k. Carnes

B. Cabinet: Steel, insulated, baked enamel finish with access panel.

C. Wheel: Cast aluminum Airfoil, statically and dynamically balanced. Cast aluminum hub.

D. Bearings: Heavy duty pillow black in enclosed duct with external grease fittings.

E. Guards: Belt.

F. Drive: See Schedule.

G. The fans shall be the square shaped and of heavy gauge formed steel. One of the sides shall be hinged and shall support the entire drive assembly (motor only for direct drive fans) and wheel allowing the assembly to swing out for cleaning, inspection or service without dismantling the unit in any way.

H. For direct drive fans, the motor shall be isolated from the air stream by a motor enclosure and shall draw cooling air from outside the fan housing.

I. For belt drive fans, the motor shall be mounted on the hinged side exterior isolated from air stream. The belt and pillow block ball bearings shall be protected from air stream by an enclosure. The shaft shall be keyed to both the wheel and pulley.

J. The fan inlet shall be spun Venturi throat overlapped by a backward curved centrifugal wheel with spun cone for maximum performance.

K. Air and sound shall be A.M.C.A. certified.

L. Install fan with spring type vibration isolators, threaded rods and expansion shields.

2.3 POWER ROOF VENTILATORS, CENTRIFUGAL

A. Manufacturers:

1. Design Basis: As scheduled
2. Acceptable Manufacturers:
    a. Greenheck
    b. Cook
    c. Carnes
    d. Aerovent
    e. Ammerman
    f. Hurricane
    g. Jenn Air
    h. Penn
    i. Powerline

B. Features:
1. Spun aluminum housing.
2. Internal rubber vibration isolators.
3. Ball bearings.

C. General:

1. Provide:
    a. Bird screen.
    b. Gravity back-draft damper:
        1) 0.2 inches WC max. pd.
    c. Motorized type backdraft damper where indicated.

D. Roof Curb:

1. Provide dimension data to Supplier of roof curbs.
2. Provide factory fabricated roof curb of height required by local authorities.

E. Sound Criteria:

1. Required sound levels may be attained by use of sound attenuating curbs.
2. Fan shall have specified capacity with curb in place.
3. Curb pressure drop is not included in specified ratings.

2.4 UP-BLAST ROOF EXHAUSTER

A. Manufacturers:

1. Design Basis: As scheduled
2. Acceptable Manufacturers:
   a. Ammerman
   b. Carnes
   c. Cook
   d. Greenheck
   e. Hurricane
   f. Jenn Air
   g. Penn
   h. Powerline

B. Features:

1. Spun aluminum housing.
2. Outside air motor cooling.
3. Grease trough.
4. Internal rubber vibration eliminators.
5. UL listed for grease laden air where noted on drawings.

C. Accessories:

1. Bird screen.

D. Provide factory fabricated curb of height required by local code.

2.5 KITCHEN EXHAUST FANS

A. Standards
1. AMCA 99, "Standards Handbook"
2. ANSI/AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans"
3. ANSI/AMCA Standard 210-99, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
4. AMCA Publication 211-05, "Certified Ratings Programme - Product Rating Manual for Fan Air Performance"
5. AMCA Standard 300-96, "Reverberant Room Method for Sound Testing of Fans"
6. AMCA Publication 311-05, "Certified Ratings Programme - Product Rating Manual For Fan Sound Performance"
7. AMBA - Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999).
8. OSHA guideline 1910.212 - General requirements for Machine Guarding. (www.osha.gov)
9. OSHA guideline 1926.300 - General requirements for safe operation and maintenance of hand and power tools. (www.osha.gov)

10. OSHA guideline 1910.219 - General requirements for guarding safe use of mechanical power transmission apparatus. (www.osha.gov)
11. UL Standard 705, "Power Ventilators"
12. UL Standard 762, "Power Roof Ventilators for Restaurant Exhaust Appliances."

B. All fans not entirely welded shall be UL 762 rated for outdoor use only. Drain connections and access doors shall be provided. All fans UL 762 listed shall be in the upblast orientation.

C. Temperature Rating:

1. 500° F maximum temperature for a minimum of 8 hours of operation.

D. Submittals

1. Provide dimensional drawings and product data on each centrifugal fan.
2. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
3. Provide outlet velocity of centrifugal fans and both inlet and outlet sound power readings for the eight octave bands.

E. Quality Assurance

1. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance.
2. Classification for Spark Resistant Construction Conform to AMCA 99.
3. Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204-96, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 0.15 in/sec peak velocity, filter-in as measured at the fan RPM. Report shall be provided at no charge to the customer upon request.

F. Delivery, Storage, and Handling

1. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
2. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.
3. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

G. General

1. Base fan performance at standard conditions (density 0.075 Lb/ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be belt in AMCA arrangement 1, 3, 9 or 10 according to drawings.
4. Fans are to be equipped with lifting lugs.
5. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

H. Fan Housing and Outlet

1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan sizes 7 through 49, in class I and II, shall be of airtight PermaLockTM Construction with the scroll panel material formed and embedded into the side panels. The housings on all fan sizes greater than 49 shall be of continuously welded heavy gauge steel. All interior and exterior surface steel shall be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be gray. No uncoated metal fan parts will be allowed.
3. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
4. An OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).
5. Provide a grease trap designed to collect grease residue to avoid drainage onto roof surface. It shall be contain a built-in water separating baffles.

I. Fan Wheel

1. The fan wheel shall be of the non-overloading single width backward inclined centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
2. Fan wheel shall be manufactured with continuously welded steel blades and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray.
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

J. Fan Motors and Drive

1. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
2. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
3. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
4. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
5. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
6. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class.
7. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
8. Bearings shall have Zerk fittings to allow for lubrication.

2.6 DRYER MAKEUP FAN

A. Manufacturers:

1. Design Basis: As scheduled
2. Acceptable Manufacturers:
   a. Trane
   b. Carrier
   c. York

d. Greenheck

B. Casing Construction

1. All unit panels shall be 2-inch solid, double-wall construction to facilitate cleaning of unit interior. All exterior and interior AHU panels will be made of galvanized steel. Motor and drive locations can be on the same side as the unit coil connections or on the opposite side. The casing shall be able to withstand up to 6" w.g. positive or negative static pressure. The unit panels shall not exceed .005 inch deflection per inch of panel span at 6" w.g. positive or negative static pressure.

C. Floor Construction

1. The unit floor shall be of sufficient strength to support a 300.0 lb load during maintenance activities and shall deflect no more than .005 inch per inch of panel span when sitting on a support structure.

D. Insulation

1. Panel insulation shall provide a minimum thermal resistance (R) value of 13 ft2*h*ºF/Btu throughout the entire unit. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel insulation shall comply with NFPA 90A.

E. Drain Pan

1. All units shall be provided with an insulated assembly of polymer material or stainless steel. To address indoor air quality (IAQ), the drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes promoting positive drainage to eliminate stagnant water conditions. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. All drain pan connections shall be visible external to the unit.

F. Access Door Construction

1. Access doors shall be 2-inch double-wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. Surface-mounted handles shall be provided to allow quick access to the interior of the unit. Handle hardware shall be designed to prevent unintended closure. Access doors shall be hinged and removable for quick, easy access. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

G. Filters

1. 2-inch pleated media filters made with 100% synthetic fibers that are continuously laminated to a supported steel-wire grid with water repellent adhesive shall be provided. Filters shall be capable of operating up to 625 fpm face velocity without loss of filter efficiency and holding capacity. The filters shall have a MERV 8 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.

H. FAN SECTION

1. The fan assembly shall be a direct-drive plenum fan with high efficiency welded-aluminum impeller that is dynamically balanced as an assembly. Fan shall be maintenance free throughout its operating life. Fans shall be balanced to G6.3 per AMCA 204. No external vibration isolation is necessary. Access to motor and fan assembly through hinged access door. Access door shall be sized for removal of entire motor and fan assembly. Motor contains integrated PID controller and accepts 0-10VDC input for variable speed control. Signal is wired back to the UC600 controller or terminal strip.

I. Fan Isolation

1. All fans, including direct drive plenum fans, shall be internally isolated to inhibit noise and vibration through the ductwork and building structure. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

J. Control Interface

1. A control interface is available that includes:
   a. Fan motor disconnect switch
   b. Transformer(s)
   c. Customer terminal strip for field-provided controls

2.7 DRYER EXHAUST FAN

A. Design Basis: Enervex

B. The Enervex modulating dryer exhaust system shall meet UL-705, 'Standard for Power Venters', and shall have a capacity as shown on the schedule. The exhaust system shall have a two-year factory warranty for parts and be of highest quality workmanship and construction. The system shall have the following features:

1. The box ventilator (BEFx) shall be suitable for indoor and outdoor installation. The BEFx shall have an insulated galvanized steel housing with a statically and dynamically balanced aluminum backwards curved centrifugal impeller. The BEFx shall have a hinged door for easy cleaning and service. The BEFx shall be designed to meet Type B, Spark Resistant Construction, and to exhaust lint-laden air from single or multiple Type I or Type II clothes dryers. The BEFx shall be equipped with an air-cooled, maintenance-free variable speed permanent magnet motor with pre-lubricated and sealed bearings. The BEFx's motor with MSC EDrive Motor Controller (EDrive) shall be rated at 92% efficiency and able to operate as low as 50 rpm. The motor shall be protected from overloading, blocking, over voltage, under voltage, and overheating. The motor shaft shall be internally isolated to eliminate the need for external shaft grounding. The motor shall be located outside the exhaust air stream to comply with the International Code Council's requirements for commercial dryer exhaust.

2. The modulating exhaust control shall be a true PID microprocessor-based control and shall be able to maintain a constant negative pressure with a tolerance of 0.01"W.C., by modulating the BEFx's motor speed via the EDrive. The control shall include a pressure transducer, silicone tubing and a duct probe. The duct's pressure shall be referenced just downstream of the clothes dryers. For multistory applications, the duct's pressure shall be referenced in the lower portion of the exhaust riser while the building's pressure shall be referenced in the lower portion of the building. The control shall operate the BEFx continuously. The control shall have a safety function to notify building management in case of insufficient pressure or ventilator failure, and indicate this with a visual alarm. The control shall have a display of the actual pressure.

3. Furnish a NEMA 4X-enclosed disconnect switch with a maximum rating of 25A and 600V for the box ventilator.

4. Contractor shall install structural, mechanical, electrical, and control connections as designed by the manufacturer and in accordance with the terms of the manufacturer's warranties.

5. Follow all pertinent national, state, and/or local codes where applicable

PART 3 - EXECUTION

3.1 NOISE AND VIBRATION

A. Insure that fans are properly supported on vibration isolators. Reference Section 23 05 48 for Vibration Isolation Requirements.

B. Insure that flexible duct connections are properly made.

C. Check fan for improper balance and have fan re-balanced if necessary.

D. Check for proper rotation.

E. Check for unusual noise or vibration and correct as necessary.

3.2 ACCESS

A. Provide for proper access to all parts of fan needing inspection or service with access doors in fan or ductwork.

3.3 INSTALLATION

A. Install units level and plumb.

B. Provide necessary auxiliary supporting steel.

C. Mount motor and drives so belts run true.

D. Provide necessary lubrication.

E. Provide flexible duct connections on inlet and discharge.

F. Provide 460v/120v transfer to serve controls and convenience outlet at all 460v fans.

G. Provide unfused disconnect of suitable capacity. Disconnect shall be weatherproof where installed outside or in a location subject to wetness.

H. Provide vibration isolators as recommended by manufacturer and other sections of this specification.

I. Provide a hinged base at all up-blast and roof curb mounted fans.

3.4 CURBS

A. Provide necessary dimensions and details so roof opening can be provided at the proper time.

B. Coordinate delivery of curb with roofing contractor so project is not delayed.

C. Provide vented roof curbs for all kitchen exhaust penetrations through roof.

D. Provide a weatherproof installation:

1. Seal all joints including, but not limited to:
   a. Unit and curb.
   b. Unit and ducts.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable and constant volume terminal units.

B. Variable volume regulators.

C. Integral heating coils.

D. Integral damper motor operators.

E. Integral controls.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 00 – Building Automation and Automatic Temperature Control Systems: Thermostats and control components.

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. ARI 880 - Air Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals.

D. UL - Shutoff terminal must be UL listed as a Room Air Terminal.

E. ASTM A 527 (Steel Sheet, Zinc Coated Galvanized)

1.4 SUBMITTALS

A. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.

B. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and radiated sound power levels (2nd through 7th octave bands) at design maximum operating conditions. Also submit Radiated Sound NC values.

Shall be calculated at design conditions with the following path attenuation credits:

CORRECTION TO OCTAVE BAND SOUND POWER VALUE						
	2	3	4	5	6	7
Env Adj	-3	-2	-1	-1-	-1	-1
Mineral Fiber Ceiling Tile	-9	-10	-12	-14	-15	-15
Space Effect Factor	-10	-11	-12	-13	-13	-14

This transfer function represents modeling assumptions based on ARI 885-90.

C. Submit manufacturer's installation instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years experience.

1.6 WARRANTY

A. Provide one year manufacturer's parts warranty.

PART 2 - PRODUCTS

2.1 OUTSIDE AIR SINGLE DUCT VARIABLE VOLUME (VAV)

A. Manufacturers:

1. Design Basis: Ruskin Company
2. Other Acceptable Manufacturers:
   a. Phoenix Controls

B. Construction:

1. Frame Material: Galvanized steel.
2. Frame Fabrication: Minimum 20 gage.
3. Blade: Modulating Air Control.
   a. Style: Butterfly, single-piece of double laminated steel.
   b. Material: Galvanized steel. 14 gage equivalent thickness. Mill finish.
   c. Seals: Polyethylene foam seal sandwiched between two layers of blade. Seal fully encompasses blade edge. Glue-on or clip-on seals not permitted.
4. Flow Sensing Blade:
   a. Style: Bullet nose, flow cross (up to 16 inches diameter).
   b. Material: Two-piece fused ABS plastic (up to 16 inches diameter).
   c. Style: Airfoil-shaped, single-piece.
   d. Material: Anodized extruded aluminum.
5. Axle: Minimum 1/2 inch diameter plated steel, mechanically attached to blade.
6. Bearings: Self-lubricating stainless steel sleeve.

C. Actuator:

1. Electric, 24 V, 60Hz, modulating

D. Controller:

1. Re-settable Constant Volume (RCV) Controller:
   a. Digital Controller Integral to Damper Actuator: Application specific controller. Programming logic and calibration in nonvolatile EPROM.
      1) Controller uses generic 0 - 10 vdc inputs and outputs for interface to building automation system.

2) Controller capable of BACnet integration to building management system for control and monitoring
3) Controller maintains CFM flow setpoint and also contains min and max CFM settings

E. Performance Data:

1. Assembly: Factory assemble damper components and furnish as a single factory calibrated unit.
2. Operating Range: 400 to 4000 feet per minute air velocity.
3. Operating Temperature: -40 degrees F to +200 degrees F (-40 degrees C to +93 degrees C).
4. Capacity: Verify capacity of damper/airflow monitor.
5. Monitor airflow within accuracy of 5 percent.
6. Leakage: Maximum .15 cubic feet per minute per inch at 4 inch w.g. of blade perimeter.

2.2 SINGLE DUCT CONSTANT (C.A.V.) AND VARIABLE (V.A.V.) VOLUME AIR TERMINAL UNITS (COMFORT)

A. Manufacturers:

1. Design Basis: Titus
2. Other Acceptable Manufacturers:
   a. Anemostat
   b. Metal Aire
   c. Enviro-Tec
   d. Carnes

B. Sound Criteria:

1. Conform to ARI 880 performance test standard.
2. Discharge Sound:
   a. 0.2” SP: NC40
   b. 1.0” SP: NC53
3. Radiated Sound:
   a. 0.2” SP: NC27
   b. 1.0” SP: NC41
4. Sound levels may be attained using attenuators, but pressure drop of attenuator must be included as part of unit pressure drop.
5. Units will discharge into lined or fiberglass ductwork, credit for which cannot be claimed in sound criteria.

C. Duct Connections:

1. Duct connections shown on drawing are minimum.
2. Units with larger connections may be used to meet pressure or sound requirements.
3. Flexible duct shall be same size as unit connection.

D. Construction:

1. The terminal casing shall be minimum 22-gauge galvanized steel, internally lined with engineered polymer foam insulation which complies to UL181 and NFPA 90A. Insulation shall be 1½ pound density, closed cell foam. Exposed fiberglass is not acceptable. The insulation shall be mechanically fastened to the unit casing. The discharge connection shall be slip and drive construction for attachment to metal ductwork.
2. Maximum leakage not exceeding 1% design flow.
3. The damper shall be heavy gauge steel with shaft rotating in Delrin® self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values.

4. Actuators shall be capable of supplying at least 35-inch lbs. of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork.

E. At an inlet velocity of 2000 fpm, the minimum static pressure required to operate any terminal size shall not exceed 0.13-inch wg for the basic terminal.

F. Heating Coils:

1. Refer to Section 23 82 16 – Air Coils.
2. Proof of flow shall be by sail switch.
3. Electric Heating Coils (SCR)
   a. Electric coils shall be supplied and installed on the terminal by the terminal manufacturer.
   b. Coils shall be ETL listed.
   c. Proportional, modulating electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step.
   d. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices
   e. Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, proportional electronic airflow sensor for proof of flow, and line terminal block.
   f. The proportional electronic airflow sensor shall be totally independent of the duct static pressure and shall adjust the heater capacity according to the available airflow. The heaters shall deliver maximum heating when needed with normal minimum airflow, reduce heating with lower than minimum airflow and stop heating with no airflow. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable.
   g. All individual components shall be UL listed or recognized.
   h. Heaters shall be equipped with a proportional SCR controller to modulate the heater load according to the temperature control signal. The electronic controller shall be compatible with the following input signals:

      1) Variable voltage signal 0-10 VDC
      2) Pulse width modulation AC or DC

G. Control:

1. Electronic, using velocity sensor, with compensation or correction for distorted flow at inlet.
2. Maximum and minimum volume controls shall be:
   a. Factory set (with allowance for altitude of project).
   b. accurate within 10%.
3. Units shall be normally open with reversing relay for use with direct acting thermostat.
4. Provide electric motor. Coordinate voltage with controls contractor, if 120V, provide integral disconnect switch in VAV box controller and transformer.
5. Coordinate spring range with Automatic Temperature Control Section.
6. Coordinate controls on CAV and VAV units with control contractor.
7. Provide CFM output to BMS.

2.3 SOUND PERFORMANCE

A. Terminal units shall not exceed the following sound criteria.

Permitted Radiated Sound Performance				
Flow	Air Pressure Drop			
	.5”	1.0”	1.5”	2”
100	11	15	17	18
200	15	21	23	25
300	22	28	25	28
400	21	27	30	33
500	22	24	27	29
600	23	27	27	29
700	22	25	29	31
800	19	23	26	29
1000	22	28	31	34
1400	22	28	28	30
1800	25	27	29	33

Permitted Discharge Sound Performance				
Flow	Air Pressure Drop			
	.5”	1.0”	1.5”	2”
100	28	29	30	31
200	29	31	34	35
300	29	33	30	33
400	25	30	34	35
500	25	29	31	34
600	26	30	34	36
700	29	33	35	38
800	25	29	30	31
1000	29	31	33	34
1400	26	30	26	29
1800	29	25	28	30

2.4 FAN POWERED BOX

A. Manufacturers:

1. Design Basis: Titus
2. Other Acceptable Manufacturers:
   a. Anemostat
   b. Enviro-Tec
   c. Carnes
   d. Metal Aire

B. Construction:

1. Galvanized steel, leakage less than 1% nominal CFM.
2. Filter rack on plenum inlet.
3. Back draft damper on fan discharge.
4. Internally insulated with minimum ½”, 1½” PCF lining per NFPA-90 and UL-181.

C. Fan:

1. Forward curved, direct drive.
2. PSC motor, permanently lubricated.
3. 3 speed selector switch.
4. P/E switch for fan on/off.

D. Coil:

1. Factory mounted air coil per Section 23 82 16.
2. Proof of flow shall be by sail switch.

E. Control:

1. Pressure independent using velocity sensor, with compensation or correction for distorted flow at inlet.
2. Maximum and minimum volume controls shall be:
   a. Factory set (with allowance for altitude of project).
   b. Accurate within 10%.
3. Units shall be normally open with reversing relay for use with direct acting thermostat.
4. Provide electrical damper motor.
5. Coordinate spring range with automatic temperature controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 23 37 00

AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 CEILING CONSTRUCTION

A. Provide products compatible with ceiling construction.

1.2 SUBMITTALS

A. Submit catalog data including throw, sound, pressure drop, physical dimensions and color.

1.3 INDUSTRY STANDARDS

A. Provide products tested in accordance with ASHRAE 70-1991 150 Standard 5219, 150 Standard 3741.

PART 2 - PRODUCTS

2.1 LINEAR SLOT DIFFUSER:

A. Manufacturers:

1. Design Basis: Titus Series ML
2. Other Acceptable Manufacturers:
   a. Carnes Series CH
   b. Krueger
   c. Metal Aire Series 6000
   d. Anemostat

B. Material: Extruded aluminum except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.

C. Finish: Baked enamel with color selected by Architect. Flat black diffuser vanes and frame interior.

D. Inlet Size: Match duct size.

E. Diffuser lengths shall be as indicated on mechanical drawings or as scheduled, whichever is greater. These are the minimum lengths required for performance. Additional lengths of inactive diffuser (“blank-off sections”) may be required by architectural scope. Contractor shall review architectural drawings for additional quantities and provide all diffusers required to meet HVAC and architectural scope.

F. Match frame and border types to ceiling system. Frame type to be appropriate to installation with diffuser elements being removable from frame. Both air pattern and flow rate adjustments with air pattern having full 180° adjustment. Single slot diffuser vanes segmented on 2 or 3 foot centers. Coordinate frame & border type with Architectural ceiling / mounting details

G. Sheet metal contractor to provide [internal sound lined] [exterior insulated] plenum, size to match drawings and/or schedule.

2.2 SLOT DIFFUSERS WITH FACTORY-SUPPLIED PLENUMS

A. Manufacturers:

1. Design Basis: Titus
2. Other Acceptable Manufacturers:
   a. Anemostat
   b. Carnes DA
   c. Kruger Series S
   d. Metal Aire Series 5000 or 5500

B. Material: Steel or aluminum except:

1. Where noted otherwise.
2. Required otherwise for fire rating.
3. Diffusers in locker rooms, showers and toilet rooms to be aluminum.

C. Finish: Baked enamel with color selected by Architect. Flat black interior.

D. Inlet Size: Match duct size.

E. Vane Air Pattern: Full 180˚ adjustment.

F. Provide [internally sound lined] [exterior insulated] plenum.

G. Match frame and border types to ceiling system.

2.3 GRILLES AND RECTANGULAR DIFFUSERS

A. Manufacturers:

1. Design Basis: Titus
2. Other Acceptable Manufacturers:
   a. Carnes
   b. Anemostat
   c. Metal Aire

B. Material: Steel or aluminum except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.
3. Grilles and diffusers in locker rooms, showers and toilet rooms to be aluminum.

C. Finish: Baked enamel with color selected by Architect.

D. Refer to Drawings for required performance.

E. Match frame and border types to ceiling system.

2.4 SQUARE CEILING DIFFUSERS:

A. Manufacturers:

1. Design Basis: Titus OMNI
2. Other Acceptable Manufacturers:
    a. Carnes Series SK or SE
    b. Krueger Series S
    c. Metal Aire Series 5000
    d. Anemostat
    e. EH Price Model AMD

B. Material: Steel or aluminum, louvered face furnished with frame type appropriate to installation, except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.
3. Grilles and diffusers in locker rooms, showers and toilet rooms to be aluminum.

C. Finish: Baked enamel except where noted, color by Architect.

D. Louver cones shall be one-piece construction with no corner joints.

E. Directional blow pattern as shown on the drawings and/or as scheduled.

F. Refer to the Drawings for required performance.

G. Match frame and border types to ceiling system.

2.5 SQUARE CEILING RETURN/EXHAUST GRILLES:

A. Manufacturers:

1. Design Basis: Titus series 350(return/exhaust)
2. Other Acceptable Manufacturers:
    a. Carnes model R series
    b. Krueger series 880
    c. Metal Aire
    d. Anemostat
    e. EH Price

B. Material: Steel or aluminum except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.
3. Grilles and diffusers in locker rooms, showers and toilet rooms to be aluminum.

C. Finish: Baked enamel except where noted, color by Architect.

D. Fixed blade (0°, 45°) core return and exhaust registers and grilles.

E. Opposed blade volume control damper return registers, operable from face.

F. Register and grille sizes as shown on drawings and/or as scheduled.

G. Screw holes on surface counter sunk to accept recessed type screws.

H. Refer to the Drawings for required performance.

I. Match frame and border types to ceiling system.

2.6 SIDE –WALL REGISTERS AND GRILLES:

A. Manufacturers:

1. Design Basis: Titus series 300(supply) and series 350(return/exhaust)
2. Other Acceptable Manufacturers:
   a. Carnes model R series
   b. Krueger series 880
   c. Metal Aire series V4000 or H4000
   d. Anemostat
   e. EH Price model NM22S/T or C22S/3

B. Material: Steel or aluminum except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.
3. Grilles and diffusers in locker rooms, showers and toilet rooms to be aluminum.

C. Finish: Baked enamel except where noted, color by Architect.

D. Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

E. Opposed blade volume control damper supply registers, operable from face.

F. Fixed blade (0°, 45°) core return and exhaust registers and grilles.

G. Opposed blade volume control damper return registers, operable from face.

H. Register and grille sizes as shown on drawings and/or as scheduled.

I. Screw holes on surface counter sunk to accept recessed type screws.

J. Refer to the Drawings for required performance.

PART 3 – EXECUTION

3.1 GENERAL

A. Refer to architectural reflected ceiling plan for exact locations and ceiling types.

B. Install grilles, registers and diffusers as shown on drawings, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serve intended purposes.

C. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

D. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

E. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.

F. Seal connections between ductwork drops and diffusers/grilles airtight.

G. Blank off unused portion of linear slot diffusers and linear bar diffusers and grilles.

H. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

I. Where registers and/or grilles cannot be installed to avoid seeing above the ceiling, paint the above the ceiling in the area of the register and/or grille with flat black paint to reduce visibility.

J. Exposed mounting screws:

1. Use tamper proof screws in countersunk holes.
2. Point screws to match frame.

K. Install security type devices in accordance with manufacturer's directions.

3.2 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the Work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, energized with normal power source, test equipment to demonstrate compliance with requirement. When possible, field correct malfunctioning units, then, retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Testing and Balancing.

END OF SECTION

SECTION 23 40 00

AIR CLEANING

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data including:

1. Media:
   a. Description
   b. Efficiency
   c. Test method
2. Enclosure
3. Support requirements
4. Weight
5. Electrical data
6. Drawings showing dimensions

1.2 QUALITY CONTROL

A. All filters shall be listed as class II per UL Standard 900.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install the air filters shown on the Drawings. The filters shall be component sections of air handling units or shall be installed in ductwork as indicated on the drawings.

B. Filters shall be as manufactured by: CamFill Farr Filtration Group Viledon Tri-Dim Corp.

C. The filter arrangements shall be as indicated in the schedule on the Drawings.

D. Fans and systems shall not be operated until protective filters have been installed. Filters which are required for operation before the Owner's acceptance of the systems shall be provided by this Contractor.

E. At the time of acceptance by the Owner, the Contractor shall install new filtering media in the high efficiency sections and shall provide new filter media rolls for all of the automatic roll type filter in which the rolls have been operated fifty percent or more of the rated capacity.

F. Air filters for built-up air handling systems shall be a combination of prefilter and after filters made by the same manufacturer and are to be so designed that the holding frames for the cartridge type after filters are installed in the structural frame of the automatic type prefilter.

G. When systems are operated during construction and balancing, prior to turning the installation over to the Owner, the after filter shall be of the dry type having an efficiently of not less than 40% an atmospheric dust by the National Bureau of Standards Dust Spot Test Method.

H. After balancing and prior to acceptance by the Owner each 40% efficient after filter cell shall be replaced with filter of the efficiency specified.

2.2 MEDIUM CAPACITY MERV 8 PLEATED AIR FILTER

A. Filters shall be medium capacity extended surface pleated air filters.

B. Filters shall be available in standard nominal depths of 1", 2", and 4".

C. Filter shall be the Camfil Farr 30/30, or an approved equal.

D. This type of filter is employed as a pre-filter in dry environments.

E. Media shall be 100% synthetic or polyester/cotton blend, mechanical media that does not support microbial growth.

F. Frame shall be a heavy duty, high strength, moisture resistant paperboard with a cross member design that increases filter rigidity and prevents breaching. Frame shall be made with 100% recycled paperboard with an average of 35% post-consumer content. Frame shall be recyclable.

G. Filters shall have a paperboard or expanded metal support grid bonded to the air-exiting side of the filter to maintain pleat uniformity and prevent fluttering. Paperboard and metal support grid shall be recyclable and contain a significant amount of post-consumer and pre-consumer content.

H. Filters shall be MERV 8 in a medium capacity configuration when fully tested in accordance with the ASHRAE 52.2-2007 Test Standard.

I. Initial resistance of filters shall not exceed the following, based on the following face velocities:

Filter Depth	Airflow Velocity	Init Pressure Drop
1”	375 fpm	0.23”w.g
2”	500 fpm	0.31” w.g
4”	500 fpm	0.31” w.g.

J. Filters shall have a recommended maximum final resistance of 1.0" w.g.

2.3 THREE-PLY MERV 8 DEPTH LOADING WIRE-RING-FRAME AIR FILTER

A. Filters shall be high capacity depth-loading wire ring panel or link filter.

B. Filters shall be available in standard nominal depths of 2".

C. Filter shall be the Tri-Dim Tri-Dek 15/40, or an approved equal.

D. This type of filter is used in primary-filtration applications where high moisture resistance is desired and where the lack of room in in the existing air handler limits the use of deeper, more efficient filters.

E. Filters shall be MERV 8 when fully tested in accordance with the ASHRAE 52.2-2007 Test Standard.

F. Initial resistance of filters shall not exceed the following, based on the following face velocity:

Filter Depth	Airflow Velocity	Init Pressure Drop
2”	500 fpm	0.48” w.g

G. Filters shall have a recommended maximum final resistance of 1.0” w.g.

2.4 HIGH PERFORMANCE RIGID-POCKET FILTER

A. Filters shall be high capacity depth-loading rigid pocket filters.

B. Filters shall be available in 18" and 26" pocket depth.

C. Filters shall be the Viledon T-60 and MF-70 products, or approved equals.

D. This type of filter is employed as primary filtration. Typical office/classroom application: MERV 10. Typical lab application: MERV 13.

E. Filter frame shall be high-impact plastic.

F. The filter media shall be manufactured from three distinct layers of organic synthetic fibers and microfibers. The pre-filter layer shall be thermally bonded to prevent fiber shedding and break-off. The micro-fiber layer shall be constructed from synthetic microfibers. Filters containing either urea-extended phenolformaldehyde binders, air-laid microfiberglass, or cotton fibers are not acceptable. The filter media shall be progressively structured to enhance depth loading and to provide lower average static resistance and longer life.

G. The filter media shall be hydrophobic and operate unaffected at relative humidity up to 100% and completely impervious to mechanical (handling) damage.

H. The filter pockets shall be injection molded into a hard polyurethane header to ensure a leak-proof seal. Pockets that are crimped into metal headers are not acceptable.

I. Filter must be supplied with factory-applied closed-cell neoprene gasketing as required for each application (either side-load gasket or down-stream gasket) to prevent air leakage and bypass. Open-cell foam is unacceptable.

J. Pockets shall be self-supporting.

K. The filter shall be fully tested in accordance with the ASHRAE 52.2-2007 Test Standard, and have a MERV Rating and Pressure drop as listed in the following table:

Filter Efficiency	Airflow Velocity	Initial Pressure Drop
MERV 13	500 fpm	0.23" w.g.

L. The filter shall have a documented wet burst strength of no less than 12" w.g.

2.5 HIGH PERFORMANCE EXTENDED SURFACE RIGID CELL

A. Filters shall be high capacity eight-panel "V" bank air filters.

B. Filters shall be available in 12.5" depth.

C. Filter shall be the Viledon MV-Series, or an approved equal.

D. This type of filter is employed as primary-filtration. Typical office/classroom application: MERV 12. Typical lab application: MERV 13.

E. Frame shall be high-impact plastic and shall contain no metal parts.

F. The filter media shall be 100% synthetic and manufactured from two distinct layers of polyester and polypropylene microfibers. The integral pre-filter layer shall be a spunbond polyester which allows the product to operate without

pre-filtration. Filter medias of wet-laid fiberglass, air-laid fiberglass, or single-layer synthetics shall be deemed unacceptable.

G. The filter media shall be hydrophobic and operate unaffected at relative humidity up to 100% and completely impervious to mechanical (handling) damage.

H. The filter media packs shall be potted within the top and bottom horizontal end caps, while the media packs shall be sealed to nonwoven vertical support stabilizers with hot melt glue that creates a molecular bond to the nonwoven vertical supports, eliminating any possibility of internal air filter bypass.

I. The filter shall incorporate a 1" offset to improve air intake performance.

J. The filter shall be independently tested to ASHRAE test standard 52.2 and have a MERV Rating and Pressure drop as listed in the following table:

K. The filter shall have a documented wet burst strength of no less than 12" w.g.

Filter Efficiency	Airflow Velocity	Initial Pressure Drop
MERV 13	500 fpm	0.23" w.g.

2.6 FILTER GAUGES

A. Provide draft gauges for each after-filter and pre-filter for measuring the resistance of the air through the filters.

B. Dwyer Mangehelic Series 2000.

C. Provide mounting bracket, tubing, static pressure tips and vent valves.

D. Gauges shall be neatly mounted on the side of the filter housing.

PART 3 – EXECUTION

3.1 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install filters and hosings where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and service intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

C. Provide vertical and horizontal stiffening bars, blank offs, angle flashing as necessary to install built up filter banks in plenum. Gasket or caulk between frame members, flashings, and blank offs.

D. Provide filter gauges to measure pressure drop of all filter banks with Type B or C filters.

E. Electric filters shall be field tested by the filter manufacturer. Filter manufacturer shall provide start up for the filters.

F. Contractor shall provide a filter replacement matrix schedule for each unit indicating size and filter type.

G. Provide and install a clean set of filters in all equipment prior to turn over to owner and one spare filter for each unit. For units with multiple filters provide a spare filter for each type.

END OF SECTION

SECTION 23 52 01

ELECTRIC BOILER

PART 1 - GENERAL

1.1 QUALITY CONTROL

A. ASME Code Symbol Stamps: Provide boilers and safety (pressure relief) valves complying with ASME Code and stamped with appropriate code symbols.

B. Equipment must be approved for installation in the city of New York and one with permanently mounted labels as required in the city of NY.

C. Hydronics Institute Insignia: Provide cast-iron boilers, which have been I-B-R (Institute of Boiler and Radiator Manufacturers) performance rated and have affixed the I-B-R insignia of the Hydronics Institute.

1.2 SUBMITTALS

A. Submit manufacturer's product data.

B. General Requirements for Boiler Suppliers:

1. The Boiler Representative shall be an authorized representative of the Boiler manufacturer and shall have been actively engaged with this manufacturer and in this field of operation for not less than five years. The installing contractor or boiler supplier shall have a service department as a permanent and integral part of his company with 24-hour service available at all times. The contractor or boiler supplier's stocking warehouse shall be no more than 100 miles from the jobsite and stock standard replacement parts for the boiler.
2. The entity responsible for boiler service during the warranty period and his 24 hour service phone number shall be specified in the O & M manual.
3. The boiler representative shall provide a factory trained and factory authorized representative to perform the following:
    a. Verify proper installation of boiler.
    b. Verify proper wiring of controls and for proper operation of the controls in accordance with the boiler listing, manufacturer's directions and Sequence of Operation given in Section 23 09 00.
    c. The above tests must be certified by the factory authorized representative performing the test.
    d. Provide free inspection and adjustment of the burner installation for the full warranty period of the installation.

1.3 WARRANTY

A. 3 year limited tank warranty with 1 year parts warranty.

PART 2 - PRODUCTS

2.1 ELECTRIC BOILER

A. The boiler vessel shall be constructed in accordance with Section IV of the ASME Boiler and Pressure Vessel Code requirements, "H" stamped and registered with the National Board of Boiler and Pressure Vessels. The vessel shall be equipped with a threaded 3" inlet, a threaded 3" outlet, safety valve and drain nozzle connections as required.

B. The vessel shall be enclosed in a rectangular 16-gauge jacket and be completely insulated with a 4" blanket of fiberglass insulation. The assembled electric boiler jacket shall have an acrylic enamel finish. Jacket shall have a full-length hinged access door with key lock for access to heating elements and controls. The assembled boiler shall have a structural steel base for ease of installation and to provide proper support as a permanent base.

C. All field electrical wiring connections to the boiler shall be made to a main terminal block. All internal wiring shall be made to solderless terminal lug wiring connections. Wiring to be color coded or numbered for ease of servicing. All power circuits to heating elements shall be fused with cartridge type fuses having a minimum 100,000 amp interrupting capacity. Operation of the heating elements shall be switched by a three pole magnetic contactors operated by a 120 volt control circuit. The control circuit shall use a built-in transformer to reduce line voltage to 120 volts for operation of the control circuit components. The control circuit shall be fused on the primary side as well as fused and grounded on the secondary side.

D. Temperature control shall be with On-Off thermostats for up to four stages of control. A proportional solid state step control shall be provided to balance heat input to demand on boilers with more than four stages of control. The hot water boiler shall be provided with an adjustable auto reset high limit control and an additional manual reset high limit control (on units with more than two stages of control).

E. The immersion heating elements shall be low watt density with an incoloy outer sheath material for long life. The heating elements shall be a three beam design and mount in individual tank flanges.

F. The electric hot water boiler shall be a complete factory package with the following trim furnished as standard: On-Off pilot switch with pilot light to manually operate the 120 volt control circuit, status pilot light for each stage of operation, preheat switch with pilot light on units above 240 kW, probe type electronic low water cut-off, pressure gauge with cock, temperature indicator, drain valve and an ASME rated pressure relief valve(s). The boiler shall be factory assembled, wired and tested. The entire hot water boiler shall be U.L. Listed and provide a 3 year limited warranty on the vessel and a 1 year limited warranty on parts.

G. Controls: Main Power Disconnect, Fused Disconnect or Automatic Breaker, Ground Fault Detector, Low Temperature Switch, Alarm Bell, Manual Limiting Switches per Step, Flow Switch, Ammeter, Voltmeter, Watt-hour Meter, Time Clock, Safety Door Interlock, High / Low Pressure Switches, Dial Temperature Gauge, Dial Pressure Gauge, Auxiliary Low Water Cut-off (float or probe type), Manual Reset Low Water Cut-off, Auto Air Vent Installed, Vacuum Breaker Installed.

H. Boiler shall be furnished with a BACnet card capable of integrating unit with the BMS.

PART 3 - EXECUTION

3.1 FIELD ASSEMBLY

A. Assemble boiler at the job site in an area designated by the Owner, convenient for installation.

B. Comply with all manufacturers' requirements.

C. Upon completion of assembly, contact Engineer and manufacturer's representative for field observation.

3.2 CLEANING

A. Flush and clean boilers upon completion of installation in accordance with manufacturer's instruction.

B. Include boiler in system for cleaning covered in Section 23 21 13.

3.3 FIELD QUALITY CONTROL

A. Test assembled boiler, boiler piping and accessories, including, but not limited to, safety and safety relief valves, gauges, etc., in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

B. Arrange with Owner's insurance carrier and State Boiler Inspector for inspection and certification of completed boiler unit.

C. Instruct the Owner's Representative in the proper operation of the boiler in the presence of the Boiler Representative.

3.4 START UP

A. Manufacturer representative shall provide factory trained personnel to start up and checkout boilers. Adjust burner to provide optimum combustion as determined from flue gas analysis.

END OF SECTION

SECTION 23 55 22

HEATING CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and Division 26 Materials and Methods, Grounding, and Wires and Cables.

1.2 SUMMARY

A. Furnish and install all electric heating cable systems as specified herein and as required for freeze protection, and heating of piping, valves, fittings, drains, etc., as indicated on the Drawings. Division of work shall be as follows:

1. Plumbing and HVAC Contractors shall provide the heating cables and power distribution panels with alarm breakers, and ground fault protection.
2. The Electrical Contractor shall receive the power distribution panels and heating cables from the plumbing Contractor and install and provide power wiring to the heat trace cables.
3. The Temperature Controls Contractor shall provide and install low voltage wiring to the BMS system and assign alarm points for each panel.

1.3 REFERENCE STANDARDS

A. Each electric heating cable system and all components shall be designed, manufactured and tested in accordance with the latest applicable UL, NEMA, and ANSI Standards as well as NFPA 70 - National Electrical Code (NEC) UL508A, with City of New York Amendments.

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed and bear an MEA listing as necessary for the City of New York in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and shall include, but not be limited to:

1. Electric Heat Tracing System including cables, fittings, thermostats, installation details, circuit capacities, operational details, power distribution panel for group control, etc.

B. Submit Shop Drawings for review prior to installation. Shop Drawings shall show the overall system and each circuit, control locations, cable lengths, current required for each circuit and feed points. Provide a summary sheet of the entire system with capacity data for each line, valve, etc. See Section 26 05 02 for Shop Drawing requirements.

1.5 WARRANTY

A. Comply with the requirements of the General Conditions and Section 26 05 02.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. Design Basis: Raychem.
   a. Model: XL-Trace for freeze protection applied between pipe and insulation.
   b. Model: Ice stop for freeze protection applied inside storm drain leaders and down spouts.
2. Other acceptable manufacturers:
   a. Thermon
   b. Nelson
   c. Chromalox

2.2 ELECTRIC HEAT TRACING SYSTEM FOR WATER PIPING

A. Heat tracing system shall be designed to maintain the water temperature within the piping to at least 40ºF, but not greater that 80 ºF, with an ambient temperature of 0ºF ambient, to maintain 40ºF pipe temperature. The piping will be insulated as specified in Division 22 in Section titled “Plumbing Insulation”.

B. Heating cables shall be UL listed electrical heating strips. The electric heat tracing may be a self regulating type of parallel circuit construction consisting of a continuous inner core of self regulating conductive material between two parallel copper bus wires suitable for operation on 120, 208 or 277 Volts, 60 hertz, single phase power. The heat tracing strips shall be capable of being cut to the desired length in the field. Operating energy shall be conserved by the self regulating feature of the heater materials, which automatically controls heat output in proportion to the heat requirement.

1. Self regulating at all points along its length.
2. 90% power reduction from 40ºF pipe temperature to 150º pipe temperature.
3. No overheating if crossed.
4. Provide outer jacket and braided copper shield for use inside roof drain leaders or on piping without a ground path.
5. UL listed and approved for use in New York City.
6. Provide tee, splice, and end seal kits as required by the manufacturer.
7. Provide ambient sensing thermostat in a NEMA 4x enclosure, with three (3) contacts rated at 22 amps each.

C. The heat trace cabling shall be controlled by power distribution panels specifically designed and built dedicated for heat trace systems. Panel shall include a 100A main breaker, rated 480 volt 3 phase, 4 wire with 277 volt branch breakers, 12 circuits with ground fault 30 mA trip, NEMA 4 panel with panel front H-O-A switch and status lights. Two sets of contacts shall be wired to the BMS, one to globally engage/disengage the heat tracing system and one alarm output.

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PART 3 - EXECUTION

3.1 SCOPE AND REQUIREMENTS

A. Furnish and install a complete electric heating cable system, including but not limited to cable, panels, ambient air sensors, aquastats, and controls, on all water piping, fittings, drains, valves, and valve bonnets as indicated on the Drawings. The Electrical Subcontractor shall coordinate the cable installation with the Mechanical and Plumbing Subcontractors. See drawings for scope and locations.

B. All installation and materials furnished shall meet the NEC requirements and be Underwriters Laboratories listed for the application.

C. The installation and all materials, conductors, conduit, etc. utilized between the electric heating cable system, controls and distribution panels shall be as specified.

D. After the piping has been successfully pressure tested, heating cables shall be installed parallel to the pipe or by spiraling the strip to obtain the heating capacity required. All cables and components shall be installed as recommended by the manufacturer by properly trained personnel using the manufacturer specified tools and procedures and as specified herein. The heating cables shall be banded to the pipe with fiberglass tape per manufacturer recommendations. After the piping has been insulated, appropriate caution signs or markings shall be provided at frequent intervals along the pipeline in accordance with NEC requirements.

E. Heat trace cable shall be installed by a licensed electrician. HVAC or Plumbing contractor shall subcontract this work to a licensed electrician if HVAC contractor is not a licensed electrician.

F. Apply the heat trace cable on the pipe after pressure testing.

1. Do not spiral wrap on pipe.
2. Make one wrap at valves.
3. Secure to pipe with methods approved by manufacturer.

G. Apply “Electrically Traced” signs on outside of insulation.

H. Heat trace shall be sized as follows, based on 0ºF ambient, to maintain 40ºF pipe temperature:

PIPE SIZE	1” INSULATION	2” INSULATION
Less than 2”	3 w/ft.	3 w/ft
2”, 2½”, 3”	5 w/ft	3 w/ft
4”, 5”, 6”	8 w/ft	5 w/ft
8”, 10”, 12”	(2 cable circuits) 8 w/ft ea.	8 w/ft

I. Provide heat tracing on all pipes installed within the intake, relief and exhaust shafts.

J. Provide heat trace on all pipes installed in enclosed perimeter shafts where separated from the exterior only by precast panels.

K. After the piping has been successfully pressure tested, heating cables shall be installed parallel to the pipe or by spiraling the strip to obtain the heating capacity required. All cables and components shall be installed as recommended by the manufacturer by properly trained personnel using the manufacturer specified tools and procedures and as specified herein. The heating cables shall be banded to the pipe with fiberglass tape per manufacturer recommendations. After the piping has been insulated, appropriate caution signs or markings shall be provided at frequent intervals along the pipeline in accordance with NEC requirements.

L. The Electrical Subcontractor shall test all electric heating cable systems for short circuits, grounds and insulation resistance. Test with 1000 VDC to a minimum resistance of 20 mega ohms.

3.2 FIELD TESTING

A. Refer to Section 26 05 03 for additional testing requirements for electric heating cable systems.

END OF SECTION

SECTION 23 56 01

SOLAR THERMAL DEVICES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Solar collectors.
2. Heat Exchanger
3. Drain Back Tank

1.2 RATINGS

A. Provide performance of collectors to be rated in accordance with ANSI/ASHRAE 93-1977.

1.3 WARRANTY

A. Provide manufacturer's standard five years written warranty on collectors.

PART 2 - PRODUCTS

2.1 SOLAR COLLECTORS

A. Manufacturers:

1. Design Basis: SunEarth
   a. ThermoRay model TRB-40.

B. Collector array size and performance:

1. Number of collectors: 7
2. Total gross area: 286.62 square feet
3. Orientation: 0
4. Tilt Angle: 40
5. Collector Field Yield: 80,112.9 kBtu
6. Irradiation onto collector area: 149,826 kBtu
7. Collector efficiency: 53.5%

C. Collectors shall be of the glazed liquid flat plate type.

D. Collectors shall be tested in conformance with ASHRAE 93-2003 and Solar Rating and Certification Corporation (SRCC)100-10, ISO 9806-1 & 9806-2 and have their thermal performance rated according to Solar Rating and Certification Corporation (SRCC) 100-10, and have their thermal performance rated according to SRCC Document RM-1. The collectors shall be certified by SRCC and listed by the International Association of Plumbing and Mechanical Officials (IAPMO).

E. General:

1. The collector dimensions shall be 122.2 inches in length, 51.37 inches in width and 3.25 inches in depth.

2. The collector casing shall be an anodized aluminum extrusion (alloy 6063 T6), minimum thickness 0.060 inch, with an architectural dark bronze finish.
3. The casing shall have notched framewalls for ease of plate removal and reinstallation. Sheet metal screwed fasteners shall be stainless steel (18-8 #10).
4. The backsheet shall be painted textured aluminum not less than 0.014 inch thickness.
5. A 1 inch vent plug shall be installed in each of the four corners of the backsheet to minimize condensation.
6. An integral mounting channel shall allow the solar collector to be mounted without penetration of the extruded aluminum casing.

F. Glazing:

1. The collector glazing shall be one sheet of low iron tempered glass, with a minimum of (0.15625 inch on EP-40-1.5), and a minimum transmissivity of 91 percent (89 on EP-40-1.5). The glazing shall be thermally isolated from the casing by a continuous EPDM gasket. There shall be a continuous secondary silicone seal between the glass and casing capstrip to minimize moisture from entering the casing.

G. Insulation:

1. The insulation shall be foil-faced polyisocyanurate foam sheathing board of a minimum 1 inch thickness, siliconed in place to the aluminum backsheet, covered by low-binder fiberglass of a minimum 1 inch thickness, providing thermal isolation of the foam from the absorber plate. Total thermal resistance shall be a minimum of R-12. The sides and ends of the collector shall be insulated with a minimum of 1 inch foil-faced polyisocyanurate foam sheathing board.

H. Absorber Plate and Piping:

1. The absorber shall consist of an aluminum plate of no less than .017 inch thickness.
2. Risers shall be a minimum of .50inch O.D. copper with a wall thickness of .025 inches on no more than 4.7 inch centers continuously laser welded to the plate.
3. The risers shall be brazed to 1.125 inch O.D. Type M copper manifolds utilizing a copper phosphorous brazing allow with no less than a minimum 5 percent silver content, and conforming to the American Welding Society's BCuP-3 classification.
4. EPDM grommets shall isolate the manifold from the aluminum casing.
5. The absorber plate shall be designed from a 160 psig maximum operating pressure and 400F maximum operating temperature.

I. Absorber Coating And Performance Curve:

1. The absorber coating shall be a moderately-selective black paint with a minimum absorptivity of 95 percent and a maximum emissivity of 5 percent. The instantaneous efficiency of the collector shall have a minimum Y-intercept of 0.753 and a slope no less than -0.735 BTU/ft2.hr. F.

2.2 DRAIN BACK TANK

A. Manufacturers:

1. Design Basis: HTP

B. Construction: 316L stainless steel

C. Provide site glass to monitor water level

D. Warranty: 5 year against leaks

2.3 DOUBLE WALLED BRAZED PLATE HEAT EXCHANGER

A. Manufacturers:

1. Design Basis: Line DW

B. Construction: SS316L stainless steel heating plates
1. Heat exchanger shall be double walled

C. Brazing Materials: Copper

D. Maximum working pressure: 481 psi

E. Maximum Working Temperature: 445 F

PART 3 - EXECUTION

3.1 COLLECTORS

A. Follow manufacturer's published installation instructions.

B. Coordinate with Architectural drawings for mounting requirements.

1. Provide necessary auxiliary support.

C. Coordinate with Control Contractor for the installation of collector temperature sensing element.

END OF SECTION

SECTION 23 57 00

HEAT EXCHANGERS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. ASME construction:

1. Provide exchanger with ASME “U” stamp.
2. Provide inspection certificate.

B. Submittals: Submit manufacturer’s product data.

1. Include the following:
   a. Materials.
   b. Design working pressure and temperature.
   c. Entering and leaving conditions…
   d. Fouling factors.
   e. Flow rates.
   f. Pressure drops.

PART 2 - PRODUCTS

2.1 PLATE AND FRAME HEAT EXCHANGERS

A. Manufacturers:

1. Design Basis: Kelvion.
2. Other Acceptable Manufacturers:
   a. Alfa-Laval
   b. Bell & Gossett
   c. Graham
   d. Tranter

B. Frame Components:

1. Preference will be given to single pass designs with all connections on the fixed cover.

2. The fixed and movable covers shall be of sufficient thickness for the design pressure and code requirements and shall have no welded reinforcements or stiffeners.

3. The carrying and guide bars shall be designed to allow for expansion of at least 15%.

4. The carrying and guide bars guiding system shall be precision manufactured of stainless steel to prohibit corrosion and facilitate movement of the plates. Painted or plated surfaces are not permitted.

5. Entire frame shall be bolted together to allow unit to be field assembled to permit rigging into place. Welding of the frame components is not permitted.

6. Plate and carrying bar design shall permit the removal or access to any plate in the plate pack without the need to remove any other plates.

7. Provide lifting lugs designed to allow lifting of the entire units flooded weight.

8. All steel surfaces shall be thoroughly cleaned and prepared for painting per SSPC-SP1063T, painting over mill scale is not acceptable. All steel components shall be Aliphatic Acrylic Polyurethane coated.

9. The fixed cover and rear support column shall be provided with carbon steel support feet.

C. Connections:

1. Connections equal to or less than 2" shall be stainless steel NPT type.

2. To avoid leakage on port area, studded port design should be provided on heat exchangers with connections greater than 2". Flanged nozzle connections are not acceptable.

3. The connection ports shall be lined with 316 stainless steel liners.

D. Compression Bolts:

1. Compression bolts shall not require special tools and shall be equipped with lock washers at the movable cover to facilitate opening and closing of the unit from the fixed cover.

2. Compression bolts shall be equipped with captive nuts at the fixed cover and threaded nuts at the movable cover. Welding of the nut to the closure bolt is prohibited.

3. Bolts shall be provided with rolled threads to reduce galling and double width hex nuts to adequately distribute the load, plus ball bearing box washers at all critical closing bolts on all units greater than 50" in height.

4. Bolts shall be liberally coated with LUBRIPLATE FML-2 for lubrication and rust prevention, and covered with a plastic protective sleeving for protection from the environment and to prevent bodily injury. Zinc plating is prohibited.

5. The bolting system shall be designed so that only (4) compression bolts are required opening and closing of the unit.

E. Plates:

1. The plate and frame heat exchanger shall consist of pressed type ALLOY 316 to provide the required heat transfer area to meet the operating conditions specified.

2. The heat transfer plates shall be at least the minimum thickness required to satisfy the unit design pressure or the plate thickness specified for the project application.

3. Individual plates shall be pressed from a homogeneous single metal sheet in one step. No multi-stage pressing of one sheet is allowed.

4. Each heat transfer plate to be with herringbone corrugations to optimize heat transfer with nominal pressure loses. Corrugations to be designed to provide support to adjacent plates at evenly distributed support points to allow pressurization of each circuit to a full differential of 1.3 times the design pressure for one hour without buckling or deformation of the heat transfer plates.

5. All plates and gaskets shall be permanently marked to identify quality and material.

6. Each heat transfer plate shall have a built-in self-aligning system to accurately locate the plates in the frame assembly and prevent lateral plate movement and maintain maximum gasket contact under pressure.

7. Plates shall be reinforced on the upper and lower mounting slots to avoid bending hangers on the plates.

8. The plate and frame heat exchanger shall be designed to perform the capacities and pressure drops as shown on the schedule. Plates to be ALLOY 316 with 2B finish and tapered gasket grooves.

9. The plate pack shall be covered with an aluminum shroud in accordance with OSHA.

F. Gaskets:

1. Gaskets shall have relieving grooves to prevent intermixing of fluids and cause leak to flow to outside of unit.

2. One piece molded CLIP-ON gaskets are required and shall fit around both the heat transfer area and the port holes.

3. Preference shall be given to non-glued gasketing systems.

4. If an adhesive is necessary, it shall be compatible with the gasket material and the fluids. The adhesive shall be a 2 component epoxy glue and heat cured.

G. Insulation:

1. Removable insulation with metal shroud.

PART 3 - EXECUTION

3.1 INSTALLATION OF PLATE TYPE HEAT EXCHANGERS

A. Coordinate with piping arrangement so that plates may be removed.

END OF SECTION

SECTION 23 81 19

SELF CONTAINED WATER COOLED AIR CONDITIONING UNITS AND HEAT PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Packaged Heat Pumps

1.2 RELATED WORK

A. Section 23 05 13 – Motors and Starters

B. Section 23 05 30 – Electronic Speed Controllers

C. Section 23 09 00 – Building Automation and Automatic Temperature Control Systems

1.3 REFERENCES

A. ARI 430 – Standard for Central Station Air Handling Units.

B. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.

C. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

D. SMACNA – HVAC Duct Construction Standards.

E. ARI 410 – Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

F. ANSI/UL 900 – Test Performance of Air Filter Units.

G. AMCA 301 – Method for Publishing Sound Ratings for Air Moving Devices.

H. ARI 320.

I. ASHRAE 90.1 – Energy Efficiency

1.4 QUALITY ASSURANCE

A. All Self Contained Air Conditioners and Heating Pump Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product offering.

B. Certify capacity, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI.

C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-87.

1.5 SUBMITTALS

A. Submit as-built drawings and product data.

B. As-built drawings shall show unit configuration in direction of airflow, and shall indicate assembly and unit dimensions.

C. Product data shall indicate dimensions, weights, capacities, fan performance, motor electrical characteristics, and finishes of materials.

D. Submit product data of filter sizes and quantities, filter performance, and filter frames.

E. Submit manufacturer's installation instructions under provisions of Section 01 __ __.

F. Provide fan curves with specified operating point clearly plotted.

G. Submit sound power levels for air handling unit(s) at scheduled conditions. If unit exceeds sound power levels at scheduled conditions, manufacturer must provide additional sound attenuators.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 23 05 03.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: ClimateMaster

2.2 GENERAL

A. Any exceptions to the specifications must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

B. Factory fabricate draw-thru type units suitable for the scheduled air pressure operation.

C. Factory fabricate units with fan section coil sections filter sections, access sections, as called for on the drawings and in accordance with this specification.

D. Factory fabricate and test air handling units of sizes, capacities, and configuration as indicated and specified. Units shall be fully assembled up to practical shipping limitations. On units not shipped fully assembled, manufacturer shall tag each section to indicate location in direction of airflow to facilitate assembly at the job site. Unit shall be shipped in sections as required to allow delivery and installation in final location.

E. Equipment shall be specifically designed for applications within conditioned interior areas.

F. Filters, threaded female water inlet and outlet connections, threaded female condensate connection, thermostat field interface terminal ship, discharge duct collar and all safety controls shall be furnished and factory installed.

G. Capacities shall be rated in accordance with ARI.

H. Equipment shall be ETL or CSA approved.

I. All equipment shall have decals and labels to aid in servicing and indicate caution areas.

2.3 DUCTED HEAT PUMPS (CLIMATEMASTER MODEL TCH)

A. General:

1. Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. Equivalent units from other manufacturers may be proposed provided approval to bid is given 10 days prior to bid closing. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

2. Where required to allow low leaving water temperatures, the jumper wire shall be clipped in accordance with manufacturer's recommendations.

3. All units shall pass a factory acceptance test. The quality control system shall automatically perform factory acceptance test via computer. A detailed report card from the factory acceptance test shall ship with each unit.

B. Cabinet Construction:

1. Horizontal units shall have one of the following air flow arrangements: Left Return/Back Discharge, Left Return/Straight Discharge, Right Return/Back Discharge, Right Return/Straight Discharge as shown on the plans. Units can be field converted without requiring new panels or belts.

2. Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-3/4 lb/ft3 (28 kg/m3) foil backed fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream.

3. Units shall be fabricated from heavy gauge galvanized steel with powder coat finish on front access panels.

4. Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

5. Horizontal units to have discharge air duct collar, 1" (25.4mm) or 2"(50.8mm) filter rails with filters factory installed, and factory installed hanger brackets. Vertical units to have discharge air duct collar shipped loose, and 1"(25.4mm) 2"(50.8mm) or 4"(101.6mm) full filter frame with filters factory installed.

6. All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable. Horizontal units shall have factory installed filter rails with filter removal from either side. Vertical units shall have factory installed full filter frame with filter removal from bottom. The contractor shall purchase one spare set of filters and replace factory shipped filters on completion of start-up. Filters shall be standard sizes. If units utilize non-standard filter sizes then the contractor shall provide 12 spare filter sets for each unit.

7. Cabinets shall have separate knockouts on front and sides for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, connections on both sides (installer to choose side and plug opposite) and shall be securely mounted flush to the cabinet side allowing for connection of a flexible hose without the use of a back-up wrench. Water connections that protrude through the cabinet or require the use of a backup wrench shall not be allowed. Water connections on only one side will not be accepted. All water connections and electrical knockouts must not interfere with the serviceability of unit. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

8. Unit shall be provided with UltraQuiet package shall consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested isolators.

C. Fan and Motor Assembly:

All units shall have belt-driven single centrifugal fan. Fan motor shall be premium duty, VFD compatible, permanently lubricated with thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. Airflow/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter, or on an ESP less than indicated shall NOT be acceptable.

D. Refrigerant Circuits:

1. All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the contractor supplied disconnect switch. Units that cannot be reset at the thermostat shall not be acceptable.

2. The scroll compressors shall have a dual level vibration isolation system. The compressor(s) will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment isolated from air stream to minimize sound transmission.

3. Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

4. The unit water circuit is protected by two high pressure switches set at 300 PSI [2067 kPa]. Switches will reset automatically when pressure is reduced. Units that do not have auto-reset water high pressure switches are not acceptable.

5. Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

6. The unit shall be supplied with extended range Insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

E. Drain Pan

1. The drain pan shall be constructed of stainless. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow unobstructed drainage of condensate. Drain outlet for horizontal units shall be connected from pan directly to 3/4" FPT fitting. For vertical units drain pan hose assembly can be connected to either side, drain outlet to be 1"FPT fitting. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches will NOT be accepted.

F. Valve & Hose Kit Assembly

1. The contractor shall have the option to provide a valve and hose kit assembly provided by the manufacturer in lieu of field provided and installed piping. The contractor shall include explicit reference to the method included in the bid price.
   a. Provide 3 ft long, braided stainless steel, fire-rated hoses complete with adapters. Hose kit shall include the following components already assembled to the hose:

1) Supply hose
   a) "Y" strainer with blowdown valve
   b) Ball valve with PT port
2) Return hose
   a) Automatic flow regulator with PT port
   b) Ball valve

b. All required components as shown on the contract drawings not listed above shall be provided by the contractor and field installed.

G. Electrical:

1. A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer with load side circuit breaker protection, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor. Two compressor units shall have a solid-state time delay relay and random start to prevent both compressors from starting simultaneously.

2. Disconnect Switch, Non-Fused, classified as motor disconnect.

H. Solid State Control System (CXM):

1. Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

   a. Anti-short cycle time delay on compressor operation.
   b. Random start on power up mode.
   c. Low voltage protection.
   d. High voltage protection.
   e. Unit shutdown on high or low refrigerant pressures.
   f. Unit shutdown on low water temperature.
   g. Condensate overflow electronic protection.
   h. Option to reset unit at thermostat or disconnect.
   i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
   j. Ability to defeat time delays for servicing.
   k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
   l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
   m. 24V output to cycle a motorized water valve or other device with compressor contactor.
   n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
   o. Water coil low temperature sensing (selectable for water or anti-freeze).
   p. Air coil low temperature sensing.

I. MPC (Multiple Protocol Control) interface system

1. Units shall have all the features listed above (either CXM or DXM) and the control board will be supplied with a Multiple Protocol interface board. Available protocols are BACnet MS/TP, Modbus, or Johnson Controls N2. The choice of protocol shall be field selectable/changeable via the use of a simple selector switch. Protocol selection shall not require any additional programming or special external hardware or software tools. This will permit all units to be daisy chain connected by a 2-wire twisted pair shielded cable. The following points must be available at a central or remote computer location:

    a. Space temperature
    b. Leaving water temperature
    c. Discharge air temperature
    d. Command of space temperature setpoint
    e. Cooling status
    f. Heating status
    g. Low temperature sensor alarm
    h. Low pressure sensor alarm
    i. High pressure switch alarm
    j. Condensate overflow alarm
    k. Hi/low voltage alarm
    l. Fan “ON/AUTO” position of space thermostat as specified above
    m. Unoccupied/occupied command
    n. Cooling command
    o. Heating command
    p. Fan “ON/AUTO” command
    q. Fault reset command
    r. Itemized fault code revealing reason for specific shutdown fault (any one of 7)

2. Provides a 75VA control transformer with load side short circuit and overload protection via a built in circuit breaker.

J. Warranty:

1. Manufacturer shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

2. Extended 4-year compressor warranty covers compressor for a total of 5 years.

3. Extended 4-year refrigeration circuit warranty covers coils, reversing valve, expansion valve and compressor for a total of 5 years.

4. Extended 4-year control board warranty covers the CXM/DXM2 control board for a total of 5 years.

2.4 DUCTED VERTICAL STACK HEAT PUMPS (CLIMATEMASTER MODEL TSL – GUEST & SUITE ROOM UNITS)

A. General:

1. Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. Equivalent units from other manufacturers may be proposed provided approval to bid is given 10 days prior to bid closing. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI / ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI / ISO and ETL-US-C labels.

2. Where required to allow low leaving water temperatures, the jumper wire shall be clipped in accordance with manufacturer's recommendations.

3. All units shall pass a factory acceptance test. The quality control system shall automatically perform factory acceptance test via computer. A detailed report card from the factory acceptance test shall ship with each unit.

B. Cabinet Construction:

1. The cabinet construction is for ducted top discharge. The cabinet panels shall be fabricated from heavy gauge galvanized steel. The rigid one-piece cabinet assembly shall be constructed so that it is self-supporting, and can be installed prior to the chassis arrival, and to be able to avoid damage during construction. Top, base, fan deck, and other metal structural parts are to be 16 gauge construction, while exterior panels to be 20 gauge; unit further strengthened by structural breaks at corners. Cabinet shall have a full panel over the chassis opening for structural rigidity of the cabinet; no "open" top or "open" bottom designs allowed.

2. The cabinet shall contain a secondary drain pan fully insulated with a pressure differential drain trap for field connection to the condensate riser pipe, and guide rails for the slide in refrigeration chassis. Drain pan to be rubber grommet mounted to provide isolation of chassis from the cabinet. Drain pan(s) shall be easily accessible for cleaning. All interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type fiberglass insulation. All insulation shall be foil faced and have exposed edges butted up to flanges to prevent the introduction of glass fibers into the air stream.

3. Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

4. Isolation pad attached to bottom of cabinet for best sound attenuation.

5. 2 inch (50mm) filter holder with 2" (50mm) thick fiberglass throwaway filter.

6. Cabinet arrangements shall allow riser piping on any one of the three sides of the cabinet not used for the chassis access. Cabinet to be top ducted. Ductwork to be field fabricated. Return K.O. to be removed from panel behind the filter. Field shall configure cabinets by removing factory Riser knockouts per model configuration shown on plans. Cabinet design shall allow a full height base board (4.50 inches/114mm) beneath the return air panel. The cabinet shall contain an easily removable motor/blower assembly.

7. Factory to provide dust protection, includes capping top opening and leaving K.O. in panel behind filter (installer to remove both).

8. Electrical connections are direct into the control compartment through top of cabinet.

9. Low voltage 15, 25, or 35 foot (572, 762, or 1,067 cm) wire harness (whip) with molex-type connector for connection to remote mounted thermostat.

10. Premium automotive grade rubber seal between cabinet inner panel and chassis.

11. Risers supply, return, and insulated condensate water risers will ship separate. Risers shall be type M copper. Riser length up to 120" (305cm) is standard. Supply and return risers have integral internal piping including ball valves (for shut off purposes at unit). Risers and piping shall be factory pressure tested to check for leaks. Field installed hose kits are required to connect the chassis piping to the cabinet ball valve. The condensate riser shall be insulated with 3/8" (9.5mm) Armaflex type insulation. The top of each riser shall be deeply swaged (3 in./76.2mm) to accept connection to the riser above/below, allowing for a floor to floor dimensional variance of ± one inch (25.4mm). Risers are shipped loose so complete riser stack can be constructed, pressure tested, and filled prior to cabinet placement. Units not having swaged riser-piping connections shall not be acceptable. Couplings and trim pieces shall not be allowed.

C. Blower and Motor Assembly:

1. The cabinet shall contain a removable motor/blower assembly. Units shall have a direct drive centrifugal fblower. Constant Volume (CV) variable speed ball bearing type motor. The fan motor shall provide soft starting, maintain constant CFM over its static operating range and provide airflow adjustment in 25 CFM increments via its control board. The fan motor shall be isolated from housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. A special dehumidification mode shall be provided to allow lower airflows in cooling for better dehumidification. The dehumidification mode may be constant or automatic (humidistat controlled).

D. Chassis:

1. The chassis, which incorporates the air coil, water coil, drain pan with solid-state electronic condensate overflow protection, compressor, and electrical components shall be easily installed for quick jobsite installation and future servicing purposes. The slide in chassis shall have insulated panels surrounding the compressor. Compressors are not in the air stream. The chassis base shall be fabricated from heavy gauge galvanized steel formed to match the slide in rails of the cabinet. Units shall have a factory installed 1 inch (25.4mm) thick filter bracket and throwaway type glass fiber filter. Furnish one spare set of filters.

2. UltraQuiet package shall consist of the standard double isolation of the compressor plus sound attenuating compressor blanket applied to the compressor. All sheet metal surrounding the compressor shall have high density sound attenuating material with STC rating of 26 per ASTM E-90 and then covered with fiberglass insulation.

3. Rib relay replaces contactor for models 09 through 18. Eliminates contactor "click" when first energized.

4. VFLow®The unit will be supplied with internally factory mounted modulating water valve with delta T control. The factory built-in valve shall modulate water flow through unit based on a field adjustable water temperature difference between the entering and leaving water. The valve shall automatically adjust for operating mode, source water temperature and variations in external head pressure. The valve will also act as a shut-off valve to prevent water flow through the unit when the unit is not activated and will have a minimum position capability.

5. Water connections between chassis and the cabinet shall be accomplished via a hose kit consisting of Kevlar-reinforced EPDM core hose surrounded by a stainless-steel braid. Hose kit shall have brass fittings with stainless-steel ferrules. AHH hose ends shall be solid External MPT which connects to mating fitting on cabinet shut off ball valve(s), and Internal NPSM (National Pipe Straight Mechanical) swivel end with fiber or EPDM washer which connects to mating threaded end connection on chassis. AHU hose ends shall be Internal NPSM (National Pipe Straight Mechanical) swivel end with fiber or EPDM washer which connects to mating threaded end connection on chassis. The hose kit shall be rated for 400 psi (2756 kPa) design working pressure.

E. Refrigerant Circuit:

1. All units shall contain a HFC-410A sealed refrigerant circuit including a high efficiency scroll or rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the contractor supplied disconnect switch. Units that cannot be reset at the thermostat shall not be acceptable.

2. Hermetic compressors shall be internally sprung and externally isolated. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor base pan, which is then isolated from the cabinet by resting on condensate drain pan which is isolated by grommets for maximized vibration attenuation. All units (except units with rotary compressors) shall include a discharge muffler to further enhance sound attenuation. Compressor shall have thermal overload protection.

3. Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Copper hairpins are tin electroplated for added protection from formicary corrosion.

4. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

5. Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

6. The unit will be supplied with internally factory mounted two-way water valve for variable speed loop pumping requirements. Valve to be normally closed type. Water circuit will have factory installed high pressure switch located between MWV and Heat Exchanger.

7. The unit will be supplied with internally factory mounted automatic water flow regulators.

F. Cabinet Drain Pan:

1. The drain pan shall be constructed of stainless steel and have a powder coat paint application to further inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. Drain pan to be isolated from cabinet with four EPDM vibration isolation grommets. Drain pan shall be fully insulated. Drain pan shall have side rails that chassis slides in and out on for ease of installation. Drain pan shall have at a minimum a doubled sloped surface to allow positive drainage to the outlet opening, which shall be at the lowest level of the entire pan surface. Drain outlet shall have factory installed rubber hose that forms trap inside of cabinet. The cabinet drain pan as standard will be supplied with solid-state electronic condensate overflow protection.

G. Hose Kit

1. Water connections between chassis and the cabinet shall be accomplished via a hose kit consisting of Kevlar-reinforced EPDM core hose surrounded by a stainless-steel braid. The hose kit shall be rated for 400 psi (2756 kPa) design working pressure. This hose kit accessory is required for each cabinet, AHH for union cap valve and AHU for sweat valve:

H. Cabinet Stand

1. Cabinet stands shall be 16 gauge galvanized steel construction. Stand shall bolt to the bottom of the cabinet.

2. A neoprene isolation pad shall be attached to the bottom of the cabinet stand.

3. Stand height shall be coordinated with mounting height of the return air panel to ensure cabinet and chassis are fully accessible through return air panel face.

I. Electrical:

1. A control compartment shall be located within the chassis and shall contain a 50VA transformer with load side circuit breaker, 24 volt activated, 2 pole compressor contactor, relay and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor. A control compartment shall be located within the cabinet and shall contain a terminal block for high voltage connections. All electrical connections between the chassis and cabinet shall be made via locking quick-connects.

2. Disconnect Switch, Non-Fused, classified as motor disconnect.

J. Solid State Control System (CXM):

1. Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.

c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device when compressor relay is active.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or antifreeze).
p. Air coil low temperature sensing.

K. MPC (Multiple Protocol Control) interface system

1. Units shall have all the features listed above (either CXM or DXM2) and the control board will be supplied with a Multiple Protocol interface board. Available protocols are BACnet MS/TP, Modbus, or Johnson Controls N2. The choice of protocol shall be field selectable/changeable via the use of a simple selector switch. Protocol selection shall not require any additional programming or special external hardware or software tools. This will permit all units to be daisy chain connected by a 2-wire twisted pair shielded cable. The following points must be available at a central or remote computer location:

a. Space temperature
b. Leaving water temperature
c. Discharge air temperature
d. Command of space temperature setpoint
e. Cooling status
f. Heating status
g. Low temperature sensor alarm
h. Low pressure sensor alarm
i. High pressure switch alarm
j. Condensate overflow alarm
k. Hi/low voltage alarm
l. Fan “ON/AUTO” position of space thermostat as specified above
m. Unoccupied/occupied command
n. Cooling command
o. Heating command
p. Fan “ON/AUTO” command
q. Fault reset command
r. Itemized fault code revealing reason for specific shutdown fault (any one of 7). This option also provides the upgraded 75VA control transformer with load side short circuit and overload protection via a built in circuit breaker.

L. Return Panel:

1. The return air panel shall be architecturally designed, acoustic type, flush mounted with hinged door for easy

and quick access to filter and unit interior. Chassis shall be easily removed. The hinged return panel shall be made of heavy gauge die formed galvanized steel with a powder coat finish. Return air panels that protrude from wall more than 7/8 inch (22mm) are not acceptable.

2. Panel shall be provided with a custom finish. Coordinate with architect for color match.

3. Provide style “G” return air panel with frame for recessing cabinet 5 inches(127mm) or more behind finished wall.

4. Panel shall have keyed locks to prevent users from tampering with units.

M. Warranty:

1. Manufacturer shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

2. Extended 4-year compressor warranty covers compressor for a total of 5 years.

3. Extended 4-year refrigeration circuit warranty covers coils, reversing valve, expansion valve and compressor for a total of 5 years.

4. Extended 4-year control board warranty covers the CXM/DXM2 control board for a total of 5 years.

2.5 CONSOLE HEAT PUMPS (CLIMATEMASTER MODEL TRC)

A. General:

1. Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard.

2. Where required to allow low leaving water temperatures, the jumper wire shall be clipped in accordance with manufacturer’s recommendations.

3. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1).

4. All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

5. All units shall pass a factory acceptance test. The quality control system shall automatically perform factory acceptance test via computer. A detailed report card from the factory acceptance test shall ship with each unit. Failed units shall not be shipped to the site.

B. Basic Construction:

1. Console units shall have one of the following air flow and piping arrangements: Front Inlet/Right-hand Piping; Front Inlet/Left-hand piping; Bottom Inlet/Right-hand piping; or Bottom Inlet/Left-hand piping as shown on the plans. If units with these arrangements are NOT used, the contractor is responsible for any extra costs

incurred by other trades. If other arrangements make servicing difficult, the contractor must provide access panels and clear routes to ease service. Architect/Engineer must approve any changes in layout.

2. The cabinet, wall mounted back wrapper and subbase shall be constructed of heavy gauge galvanized steel with a baked polyester powder coat paint finish. Corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. Color will be Polar Ice. Both sides of the steel shall be painted for added protection. Additionally, the wall mounted back wrapper shall have welded corner bracing. The easily removable cabinet enclosure allows for easy service to the chassis, piping- and control compartments.

3. All interior surfaces shall be lined with 1/4 inch (6.4mm) thick, 2 lb/ft3 (32 kg/m3) acoustic flexible blanket type glass fiber insulation with a non-woven, anti-microbial treated mat face. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

4. The cabinet shall have a 30º sloped top with aluminum rigid bar type discharge grille. Aluminum discharge grille shall be anodized charcoal grey in color including hinged control door. Cabinet shall have rounded edges (0.325 inch / 8.255 mm minimum radius) on all exposed corners for safety and aesthetic purposes.

5. Return Air Filter shall be 1" (25.4mm) fiberglass disposable type media for bottom return units (units with sub-base) or 1/8" (3.2mm) permanent cleanable type media for front return type units.

6. The unit shall be provided with a keyed lock on the control access door.

7. The unit shall include a front return air grille integrally stamped into Cabinet (subbase not required).

8. UltraQuiet package shall consist of high technology sound attenuating material that is strategically applied to the compressor and compressor compartment in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested EPDM isolators.

C. Fan and Motor Assembly:

1. Fan and motor assembly shall be assembled on a slide out fan deck with quick electrical disconnecting means to provide and facilitate easy field servicing. The fan motor shall be multi-speed, permanently lubricated, PSC type, with internal thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall include a torsionally flexible motor mounting system or saddle mount system with resilient rings to inhibit vibration induced high noise levels associated with "hard wire belly band" motor mounting. The airflow rating of the unit shall be based on a wet coil and a clean filter in place.

D. Refrigerant Circuit:

1. All units shall contain HFC-410A sealed refrigerant circuit including a high efficiency rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced

corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the optional disconnect switch.

2. Hermetic compressors shall be internally sprung. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

3. Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

4. Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

5. The unit will be supplied with internally factory mounted two-way water valve for variable speed pumping requirements. A factory-mounted or field-installed high pressure switch shall be installed in the water piping to disable compressor operation in the event water pressures build due to water freezing in the piping system.

6. The unit will be supplied with internally factory mounted automatic water flow regulators.

E. Piping:

1. Water piping shall terminate in the same location regardless of the connection and valve options. Threaded MPT copper fittings.

F. Valve & Hose Kit Assembly

1. Provide 1 ft long, braided stainless steel, fire-rated hoses complete with adapters. Hose kit shall include the following components already assembled to the hose:

a. Supply hose
   1) "Y" strainer with blowdown valve
   2) Ball valve with PT port
b. Return hose
   1) Automatic flow regulator with PT port
   2) Ball valve

2. All required components as shown on the contract drawings not listed above shall be provided by the contractor and field installed

G. Drain Pan:

1. The drain pan shall be constructed of stainless steel and have a powder coat paint application to further inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117Drain pan shall be insulated. Drain outlet shall be located at pan as to allow complete and unobstructed drainage of condensate. The unit as standard will be supplied with solid-state electronic condensate overflow protection.

H. Electrical:

1. Unit control shall be located under the hinged control door in the sloped top grille. Operating control shall consist of push buttons to select mode of operation "OFF", "HEAT," "COOL," "AUTO", Fan "AUTO" (fan cycles with compressor), Fan "ON" (continuous fan), Fan "LO" (low speed fan), and Fan "HI" (high speed fan). Temperature adjustment shall be accomplished via two push buttons, one labeled with an arrow up, and the other labeled with an arrow down. Control shall include an LCD display for display of temperature and setpoint.

2. A control box shall be located above the unit compressor compartment and shall contain operating controls as outlined in the paragraph above, 24VAC transformer, double-pole compressor relay, and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. A unit-mounted digital thermostat with a remote sensor measuring return air temperature shall control the compressor operation for heating and cooling. Field can configure digital ACO unit mounted thermostat for MCO operation, F or C temperature reading, and offset.

3. Provisions for remote thermostat (single fan speed).

4. Disconnect Switch, Non-Fused.

I. Solid State Control System (CXM):

1. Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

   a. Anti-short cycle time delay on compressor operation.
   b. Random start on power up mode.

c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or anti-freeze).
p. Air coil low temperature sensing.

J. MPC (Multiple Protocol Control) interface system:

1. Units shall have all the features listed above (either CXM or DXM) and the control board will be supplied with a Multiple Protocol interface board. Available protocols are BACnet MS/TP, Modbus, or Johnson Controls N2. The choice of protocol shall be field selectable/changeable via the use of a simple selector switch. This will permit all units to be daisy chain connected by a 2-wire twisted pair shielded cable. The following points must be available at a central or remote computer location:

a. space temperature
b. leaving water temperature
c. discharge air temperature
d. command of space temperature setpoint
e. cooling status
f. heating status
g. low temperature sensor alarm
h. low pressure sensor alarm
i. high pressure switch alarm
j. condensate overflow alarm
k. hi/low voltage alarm
l. fan “ON/AUTO” position of space thermostat as specified above
m. unoccupied/occupied command
n. cooling command
o. heating command
p. fan “ON/AUTO” command
q. fault reset command
r. itemized fault code revealing reason for specific shutdown fault (any one of 7)

2. This option also provides the upgraded 75VA control transformer with load side short circuit and overload protection via a built in circuit breaker.

K. Warranty:

1. Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

2. Extended 4-year compressor warranty covers compressor for a total of 5 years.

3. Extended 4-year refrigeration circuit warranty covers coils, reversing valve, expansion valve and compressor for a total of 5 years.

4. Extended 4-year control board warranty covers the CXM/DXM control board for a total of 5 years.

PART 3 - EXECUTION

3.1 GENERAL

A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.

B. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance and filter replacement and coil removal with minimum disturbance of piping.

C. Prior to unit start-up all controls shall be installed and tested.

D. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.

E. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.

F. Install units with adequate clearances to access valves, open access doors fully, for coil pull and NEC clearances in front of disconnect switches.

END OF SECTION

SECTION 23 81 20

SELF CONTAINED WATER COOLED ROOFTOP HEAT PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Packaged Rooftop Heat Pumps

1. DOAS-2
2. MUA-1

1.2 RELATED WORK

A. Section 23 05 13 – Motors and Starters

B. Section 23 05 30 – Electronic Speed Controllers

C. Section 23 09 00 – Building Automation and Automatic Temperature Control Systems

1.3 REFERENCES

A. ARI 430 – Standard for Central Station Air Handling Units.

B. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.

C. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

D. SMACNA – HVAC Duct Construction Standards.

E. ARI 410 – Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

F. ANSI/UL 900 – Test Performance of Air Filter Units.

G. AMCA 301 – Method for Publishing Sound Ratings for Air Moving Devices.

H. ARI 320.

I. ASHRAE 90.1 – Energy Efficiency

1.4 QUALITY ASSURANCE

A. All Self Contained Air Conditioners and Heating Pump Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product offering.

B. Certify capacity, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI.

C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-87.

D. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and

Cooling Equipment.

E. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

F. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

G. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.5 SUBMITTALS

A. Submit as-built drawings and product data.

B. As-built drawings shall show unit configuration in direction of airflow, and shall indicate assembly and unit dimensions.

C. Product data shall indicate dimensions, weights, capacities, fan performance, motor electrical characteristics, and finishes of materials.

D. Submit product data of filter sizes and quantities, filter performance, and filter frames.

E. Provide fan curves with specified operating point clearly plotted.

F. Submit sound power levels for air handling unit(s) at scheduled conditions. If unit exceeds sound power levels at scheduled conditions, manufacturer must provide additional sound attenuators.

G. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 23 05 03.

B. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

C. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

D. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 WARRANTY

A. Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: AAON

B. Other Acceptable Manufacturers:

1. FTP
2. York
3. Trane
4. Daikin McQuay

C. Substitute equipment may be considered for approval that includes at a minimum:

1. R-410A refrigerant

2. Variable capacity compressor with 10-100% capacity control

3. Direct drive supply fans

4. Double wall cabinet construction

5. Insulation with a minimum R-value of 13

6. Stainless steel drain pans

2.2 GENERAL

A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, water-cooled condenser, exhaust fans, energy recovery wheels, and unit controls.

B. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment’s literature pocket.

C. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

D. Unit components shall be labeled, including refrigeration system components and electrical and controls components.

E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.

F. Installation, Operation, and Maintenance manual shall be supplied within the unit.

G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.

H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

2.3 CONSTRUCTION

A. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

B. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.

C. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.

D. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRIStandard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

E. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.

F. Access to filters, dampers, cooling coils, reheat coil, heaters, compressors, water-cooled condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

G. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

H. Units with cooling coils shall include double sloped 304 stainless steel drain pans.

I. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.

J. Unit shall include lifting lugs on the top of the unit.

K. Unit base pan shall be provided with 1/2 inch thick foam insulation.

L. Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.

2.4 ELECTRICAL

A. Unit shall have a 5kAIC SCCR.

B. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.

C. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.

D. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

E. Unit shall be provided with remote stop/start terminals which require contact closure for unit operation. When these contacts are open the low voltage circuit is broken and the unit will not operate.

2.5 SUPPLY FAN(S)

A. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

B. Blowers and motors shall be dynamically balance and mounted on rubber isolators.

C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

2.6 EXHAUST FAN(S)

A. Exhaust dampers shall be sized for 100% relief.

B. Fans and motors shall be dynamically balanced.

C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.

E. Unit shall include belt driven, unhoused, backward curved, plenum exhaust fans.

F. Unit shall include direct drive, axial flow exhaust fans. Blades shall be adjustable pitch.

G. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

2.7 COOLING COILS

A. Evaporator Coils

1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.

2. Coils shall have interlaced circuitry and shall be standard capacity.

3. Coils shall be hydrogen or helium leak tested.

4. Coils shall be furnished with factory installed expansion valves.

2.8 REFRIGERATION SYSTEM

A. Unit shall be factory charged with R-410A refrigerant.

B. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

C. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.

D. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

E. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.

F. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.

G. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.

H. Unit shall include a variable capacity scroll compressor on all refrigeration circuits which shall be capable of modulation from 10-100% of its capacity.

I. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal whichallow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

J. Unit shall be configured as a water-source heat pump. Each refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, and expansion valves on both the indoor coil and refrigerant-to-water heat exchanger. Reversing valve shall energize during the heat pump cooling mode of operation.

K. Each refrigeration circuit shall be equipped with a liquid line sight glass.

2.9 CONDENSERS

A. Water-Cooled Condenser

1. Water-cooled condensing section shall contain plate type, heat exchangers located in an insulated vestibule. Heat exchangers shall be circuited in a counter flow arrangement to the refrigerant system. Plates shall be stainless steel. Each heat exchanger shall be provided with a removable and cleanable type, basket filter on the waterside circuit. Field piping connections shall be made at each plate heat exchanger within the condensing section of the rooftop unit. Maximum operating pressure on the water side of the condenser shall be 125 psi.

2. All field installed piping shall be hydrostatically tested before being put into service. Test pressure shall be 125 psi for a 2 hour duration. Leaks and loss in test pressure constitute defects. If test fails, corrections shall be made to the system and the test shall then be repeated to make certain all defects were corrected. All testing shall be performed to ASTM Standards.

3. Each heat exchanger circuit shall have a flow switch that shuts down the compressors if water flow to the condenser is interrupted

4. Unit shall include factory installed head pressure control module and each heat exchanger shall include factory installed head pressure control valve which modulates the condenser water flow based on head pressure and allows cooling operation below 65°F condenser water temperature.

2.10 ELECTRIC HEATING

A. Unit shall include an electric heater consisting of electric heating coils, fuses and a high temperature limit switch, with capacities as shown on the plans.

B. Electric heating coils shall be located in the preheat position upstream of the cooling coil.

C. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.

D. Emergency electric heating capacity shall be sized by determining the maximum electric heating capacity not to exceed the amp draw of all compressors and adding that electric heating capacity to the auxiliary electric heating capacity. Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.

2.11 FILTERS

A. Unit shall include 4 inch thick, pleated panel filters with an ASHRAEMERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.

B. Unit shall include a clogged filter switch.

C. Unit shall include a Magnehelic gauge mounted in the controls compartment.

2.12 OUTSIDE AIR/ECONOMIZER

A. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return sensible temperature activated fully modulating enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

2.13 CONTROLS

A. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.

B. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

C. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

D. Makeup Air Controller

1. Unit shall modulate cooling with constant airflow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.

2. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet outside air humidity loads and prevent supply air temperature swings and overcooling of the space.

3. Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.

E. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network.

2.14 ACCESSORIES

A. Unit shall be provided with a smoke detector sensing the supply air of the unit, wired to shut off the unit's control circuit.

B. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

2.15 CURBS

A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

B. Knockdown curb (with duct support rails) shall be factory furnished for field assembly.

C. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)

PART 3 - EXECUTION

3.1 GENERAL

A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.

B. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance and filter replacement and coil removal with minimum disturbance of piping.

C. Prior to unit start-up all controls shall be installed and tested.

D. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.

E. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.

F. Install units with adequate clearances to access valves, open access doors fully, for coil pull and NEC clearances in front of disconnect switches.

G. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.

H. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

SECTION 23 81 21

SELF CONTAINED WATER COOLED INTERIOR HEAT PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Self Contained Indoor Heat Pumps

1. DOAS-1
2. GSHP-L-1

1.2

1.3 RELATED WORK

A. Section 23 05 13 – Motors and Starters

B. Section 23 05 30 – Electronic Speed Controllers

C. Section 23 09 00 – Building Automation and Automatic Temperature Control Systems

1.4 REFERENCES

A. ARI 430 – Standard for Central Station Air Handling Units.

B. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.

C. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

D. SMACNA – HVAC Duct Construction Standards.

E. ARI 410 – Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

F. ANSI/UL 900 – Test Performance of Air Filter Units.

G. AMCA 301 – Method for Publishing Sound Ratings for Air Moving Devices.

H. ARI 320.

I. ASHRAE 90.1 – Energy Efficiency

1.5 QUALITY ASSURANCE

A. All Self Contained Air Conditioners and Heating Pump Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product offering.

B. Certify capacity, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI.

C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-87.

D. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

E. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

F. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

G. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.6 SUBMITTALS

A. Submit as-built drawings and product data.

B. As-built drawings shall show unit configuration in direction of airflow, and shall indicate assembly and unit dimensions.

C. Product data shall indicate dimensions, weights, capacities, fan performance, motor electrical characteristics, and finishes of materials.

D. Submit product data of filter sizes and quantities, filter performance, and filter frames.

E. Provide fan curves with specified operating point clearly plotted.

F. Submit sound power levels for air handling unit(s) at scheduled conditions. If unit exceeds sound power levels at scheduled conditions, manufacturer must provide additional sound attenuators.

G. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 23 05 03.

B. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

C. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

D. Unit shall be handled carefully to avoid damage to components, enclosures and finish.

E. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 WARRANTY

A. Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: AAON

B. Other Acceptable Manufacturers:

1. FTP
2. York
3. Trane
4. Daikin McQuay

C. Substitute equipment may be considered for approval that includes at a minimum:

1. R-410A refrigerant
2. ECM driven direct drive backward curved plenum supply fans
3. Double wall cabinet construction
4. Insulation with a minimum R-value of 6.25
5. Double sloped stainless steel drain pans
6. Hinged access doors with lockable handles
7. Variable capacity compressor with 10-100% capacity
8. Factory installed acoustic insulation in the compressorized section
9. Designed, engineered, and manufactured in the United States of America
10. All other provisions of the specifications must be satisfactorily addressed

2.2 GENERAL

A. Self contained unit shall include compressors, evaporator coils, filters, supply fans, energy recovery wheel, and unit controls.

B. Unit shall be factory assembled and tested including and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.

C. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

D. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

E. Installation, Operation and Maintenance manual shall be supplied within the unit.

F. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.

G. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

2.3 CONSTRUCTION

A. Unit shall be provided with a horizontal intake, have a draw-through supply fan configuration and discharge air vertically.

B. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

C. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.

D. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel and prevents exterior condensation on the panel.

E. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical wiring through cabinet panels shall include sealing to reduce air leakage.

F. Access to filters, compressors, cooling coil, condensers, supply fans and electrical, energy recovery wheeland controls components shall be through hinged access doors.

G. Access doors shall be flush mounted to cabinetry, with stainless steel removable pin hinges and zinc cast lockable handles. Unit shall include a 304 stainless steel sloped drain pan. Drain pan connection shall be available on the right (left) side of the air handling section of the unit.

H. Cooling coils shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

I. Unit shall include a 5-inch forklift base.

2.4 ELECTRICAL

A. Unit shall be provided with an integrated control panel.

B. Unit shall be provided with standard power block for connecting power to the unit.

C. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage to the unit.

D. Unit shall have a 5kAIC SCCR.

E. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

F. Unit shall be provided with blower auxiliary contacts on the low voltage terminal block which close when the supply fans are energized.

G. Unit shall be provided with remote stop/start terminals which require contact closure for unit operation. When these contacts are open the low voltage circuit is broken and the unit will not operate.

H. Unit shall be provided with manual reset low temperature limit controls which shut off the unit when the discharge temperature reaches a field adjustable setpoint

2.5 SUPPLY/EXHAUST FAN(S)

A. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

B. Fan and motor assembly shall be dynamically balanced.

C. Motors shall be a high efficiency electronically commutated motor (ECM).

D. Supply air shall discharge vertically from the unit.

E. Blower and motor assembly shall be mounted on rubber isolators.

2.6 COOLING COILS

A. Evaporator Coils

1. Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

2. Coil shall two circuits and interlaced circuitry.

3. Coil shall be hydrogen or helium leak tested.

4. Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.

5. Drain pan shall be provided with overflow switch which shuts down the cooling circuits.

2.7 REFRIGERATION SYSTEM

A. Unit shall be factory charged with R-410A refrigerant.

B. Compressors shall be R-410A scroll type with thermal overload protection and independently circuited.

C. Unit shall include a variable capacity scroll compressor which shall be capable of modulation from 10-100% of its rated capacity.

D. Compressor shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

E. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.

F. Compressors shall be isolated from unit with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressor into the building area.

G. Unit shall be equipped with thermostatic expansion valve type refrigerant flow control.

H. Unit shall be configured as a water-source condensing unit.

I. Unit shall be configured as a water-source heat pumpUnit shall be equipped with an automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, factory installed liquid line heat pump filter drier, reversing valve and thermostatic expansion valves on the indoor coil. Reversing valve shall energize during the cooling mode of operation.

J. Each refrigeration circuit shall be equipped with a liquid line sight glass.

2.8 CONDENSERS

A. Water-Cooled Condenser

1. Water-cooled condensing section shall contain plate type, heat exchangers located in an insulated vestibule. Heat exchangers shall be circuited in a counter flow arrangement to the refrigerant system. Plates shall be stainless steel. Each heat exchanger shall be provided with a removable and cleanable type, basket filter on the waterside circuit. Field piping connections shall be made at each plate heat exchanger within the condensing section of the rooftop unit. Maximum operating pressure on the water side of the condenser shall be 125 psi.

2. All field installed piping shall be hydrostatically tested before being put into service. Test pressure shall be 125 psi for a 2 hour duration. Leaks and loss in test pressure constitute defects. If test fails, corrections shall be made to the system and the test shall then be repeated to make certain all defects were corrected. All testing shall be performed to ASTM Standards.

3. Each heat exchanger circuit shall have a flow switch that shuts down the compressors if water flow to the condenser is interrupted

4. Unit shall include factory installed head pressure control module and each heat exchanger shall include factory installed head pressure control valve which modulates the condenser water flow based on head pressure and allows cooling operation below 65°F condenser water temperature.

2.9 FILTERS

A. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, in a prefilter box upstream of the cooling coil.

B. 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.

C. Unit shall include a clogged filter switch.

2.10 ENERGY RECOVERY

A. Where scheduled, unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.

B. Wheel frame shall slide out for service and removal from the cabinet.

C. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

D. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.

E. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

F. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

G. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

H. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Air exchange. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Air exchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.

I. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the wheels.

J. Hinged service access door shall allow access to the wheel.

K. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

L. Unit shall include energy recovery wheel rotation detection sensors and a set of normally open and normally closed contracts for field indication of wheel rotation.

2.11 OUTSIDE AIR/ECONOMIZER

A. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in.

w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return sensible temperature activated fully modulating enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

2.12 CONTROLS

A. Factory Installed and Factory Provided Controller

1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.

2. Controller shall be capable of stand-alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.

3. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

4. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

5. Variable Air Volume Controller

a. Unit shall utilize a variable capacity compressor system and a variable speed supply fan system to modulate cooling and airflow as required to meet space temperature cooling loadsand to save operating energy. Supply fan speed shall modulate based on supply air duct static pressure. Cooling capacity shall modulate based on supply air temperature.

b. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.

c. Unit shall modulate heating with constant airflow to meet space temperature heating loads. Staged heating capacity shall modulate based on space temperature.

d. Unit shall modulate heating with constant airflow to meet space temperature heating loads. Modulating heating capacity shall modulate based on supply air temperature.

e. Return air temperature sensor, supply air temperature sensor, and supply air duct static pressure sensor shall be furnished with the unit for field installation.

f. Control of supply airflow, for duct static pressure control, shall be with unit controller, factory installed electronically commutated motor, and supply air duct static pressure sensor.

g. With the modulating hot gas reheat option a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.

6. Make Up Air Controller

a. Unit shall modulate cooling with constant airflow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.

b. Hot gas bypass shall be required on the lead refrigeration circuits of systems without variable capacity compressors.

c. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet outside air humidity loads and prevent supply air temperature swings and overcooling of the space.

d. Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.

e. Supply air temperature sensor and outside air temperature sensor shall be furnished with the unit for field installation.

f. With the modulating hot gas reheat option an outside air humidity sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.

B. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network.

2.13 ACCESSORIES

A. Unit shall be provided with a smoke detector shipped loose for sensing the supply air of the unit, to be wired to shut off the unit's control circuit.

B. Unit shall be provided with a low voltage safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

PART 3 - EXECUTION

3.1 GENERAL

A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.

B. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance and filter replacement and coil removal with minimum disturbance of piping.

C. Prior to unit start-up all controls shall be installed and tested.

D. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.

E. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal,

combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.

F. Installation, Operation and Maintenance manual shall be supplied with the unit.

G. Install units with adequate clearances to access valves, open access doors fully, for coil pull and NEC clearances in front of disconnect switches.

H. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.

I. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

SECTION 23 81 26

SPLIT SYSTEM DX AIR CONDITIONING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Split System DX air handling units.

B. Refrigeration components.

1.2 RELATED SECTIONS

A. Section 23 05 13 – Motors and Starters

B. Section 23 40 00 – Air Cleaning

1.3 REFERENCES

A. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration.

B. ANSI/ASHRAE/IES 90.1A – 2001 - Energy Conservation in New Building Design Standard.

C. ARI 210/240 – Unitary Air-Conditioning Equipment and Air-Source Heat Pump Equipment, (less than 135,000 Btuh).

D. ARI 360 – Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard, (equipment greater than 135,000 Btuh).

E. ARI 340 – Commercial and Industrial Unitary Heat Pump Equipment, (heat pumps above 135,000 Btuh).

F. ANSI Z21.47/UL1995 – Unitary Air Conditioning Standard for safety requirements.

1.4 QUALITY ASSURANCE

A. Air Handling Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product.

1.5 SUBMITTALS

A. Submit unit performance data including capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 WARRANTY

A. Provide one year parts warranty.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

A. Acceptable Manufacturers: LG Electronics.

B. Indoor Unit

1. Furnish and install a ductless-split air conditioning system as shown on the plans and as listed below. The indoor unit shall be factory assembled, wired, and run tested.
2. The unit cabinet shall be supplied with a separate back plate and multi-directional drain and refrigerant piping. The casing shall have a white finish. Cabinet shall be rigidly mounted to the wall without vibration.
3. The evaporator fan shall be an assembly with a line-flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The fan shall consist of three (3) speeds: High, Medium, and Low.
4. A manual adjustable guide vane shall be provided.
5. Return air shall be filtered by means of easily removed, washable, Catechin, Antioxidant Pre-filter, and an Anit-allergy enzyme filter – blue bellows type.
6. The evaporator coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner groves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. Coils shall be pressure tested at the factory.
7. A condensate pan and drain shall be provided under the evaporator coil.
8. The unit shall have a wireless controller to perform input functions necessary to operate the system and have a field installed hard-wired remote controller. The controller shall consist of a power on/off switch, mode selector, temperature setting, timer control, fan speed selector and auto vane selector. The unit shall perform self-diagnostic function, test run switching, and check mode switching. Temperature changes shall be by 1 F increments with a range of 65-87 F. The microprocessor shall have the capability of sensing return air temperatures and indoor coil temperature, receiving and processing commands from the wireless and wired controller, provide emergency operation and controlling the outdoor unit.
9. The unit shall be equipped with pulse amplitude modulation (PAM) control for efficiency. Indoor unit shall be powered directly from the outdoor unit.

C. Outdoor Unit

1. Furnish and install split air conditioning system as shown on the plans and as listed below.
2. The outdoor unit shall be completely factory assembled, piped, wired, and run tested.
3. The casing shall be fabricated of galvanized steel, bonderized, finished with electrostatically applied, thermally fused acrylic powder coating for corrosion protection.
4. The condenser unit shall be furnished with a direct drive propeller type fan with permanently lubricated bearings. The fan shall be provided with a raised guard to prevent contact with moving parts. The unit shall have a horizontal discharge airflow.
5. The condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing and shall be protected with an integral metal guard. The refrigerant flow from the condenser shall be controlled by means of a metering orifice.
6. The compressor motor shall be of a high performance hermetic, inverter driven, variable speed, rotary type. The unit shall have an accumulator. The compressor shall be equipped with an internal thermal overload. The unit must have the ability to operate with a maximum height difference of 35 feet and have a refrigerant tubing length of 65 feet between the indoor and outdoor units without the need for line size changes, traps, or additional oil. The compressor shall be mounted to avoid the transmission of vibration.
7. Low ambient operation shall be provided and shall be accomplished by means of an opposed blade damper assembly as furnished by the manufacturer and field installed at the condenser air inlet and connected to the factory mounted schreader fitting on the liquid line. This is to be accomplished without loss of refrigerant. Unit is to operate effectively to 0 degree Fahrenhiet.
8. The unit shall be capable of satisfactory operation with voltage limits of 198V to 253V. The outdoor unit shall be controlled by a microprocessor located in the indoor unit and outdoor unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install unit on vibration isolators. Reference Section 23 05 48.

C. Locate condensing unit in general position indicated in relation to other work.

1. Position for sufficient clearance for normal service and maintenance, including clearance for cleaning and replacement of tubes, filters, motor, etc.

D. Charge with refrigerant in the quantity recommended by the manufacturer.

1. Bleedout non-condensable gases.
2. Test refrigerant system for leakage in manner recommended by manufacturer.

E. Install pressure relief system in compliance with governing regulations, to vent refrigerant in manner indicated.

F. Install refrigerant piping (Type ACR copper tube) in accordance with manufacturers recommendations, and per the drawings.

1. Comply with the Clean Air Act.
2. Provide filter/dryer, site glass and service/isolation valves for each circuit.
3. Run piping plumb. Slope as required for proper oil return and to protect compressor.
   a. Provide oil trap at bottom of suction risers.

G. Provide for vibration and expansion of piping.

3.2 START-UP

A. Sustained Operation: Do not place unit in sustained operation prior to initial balancing of mechanical systems affected by unit operation.

B. Cooperate with other trades and installers of other work during testing, adjusting, balancing and start-up of mechanical systems.

C. Start up and first year parts and labor to be provided by equipment manufacturer.

END OF SECTION

SECTION 23 81 27

VARIABLE REFRIGERANT FLOW (VRF) DX AIR CONDITIONING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged VRF DX air handling units.

B. Refrigeration components.

1.2 RELATED SECTIONS

A. Section 23 05 13 – Motors and Starters

B. Section 23 40 00 – Air Cleaning

1.3 REFERENCES

A. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration.

B. ANSI/ASHRAE/IES 90.1A – 2001 - Energy Conservation in New Building Design Standard.

C. ARI 210/240 – Unitary Air-Conditioning Equipment and Air-Source Heat Pump Equipment, (less than 135,000 Btuh).

D. ARI 360 – Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard, (equipment greater than 135,000 Btuh).

E. ARI 340 – Commercial and Industrial Unitary Heat Pump Equipment, (heat pumps above 135,000 Btuh).

F. ANSI Z21.47/UL1995 – Unitary Air Conditioning Standard for safety requirements.

G. ISO 9001 Quality Management System

H. ISO 14001 Environmental Management System

I. Underwriters Laboratories (UL) 1995 Heating and Cooling Equipment Standard for Safety and bear the Electrical Testing Laboratories (ETL) label.

J. National Electrical Code (NEC) and all applicable state and local building codes.

K. Performance ratings certified by AHRI (Air-Conditioning, Heating, and Refrigeration Institute) and listed in the AHRI Standard 1230 certified product directory.

1.4 QUALITY ASSURANCE

A. Air Handling Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product.

B. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

C. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

E. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

F. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.5 SYSTEM PERFORMANCE DOCUMENTATION

A. The VRF manufacturer shall provide published outdoor unit performance data in table format which states the products heating and cooling capacity expressed in British thermal units per hour (BTUH) and power consumption expressed in kilowatts (kW). Performance data published at any and all operating conditions, including ambient outdoor air temperature, entering indoor unit air temperature, and proposed combination ratio (CR = sum of nominal cooling capacity of proposed indoor units/nominal cooling capacity of the outdoor unit) in these tables must guarantee continuous compressor operation. Tabular data that communicates performance at conditions where compressor may or may not be operating (commonly referred to as 'Reference data') is not acceptable documentation for VRF system performance. Any product whose system design and engineering manuals or guides where published data tables are expressed in units other than these specified will not be accepted.

B. Any product whose published documentation requires the design engineer to manually apply a correction factor derived from a published curve against nominal capacity to obtain corrected capacity shall not be accepted. Correction factor curves including but not limited to: a) Outdoor air temperature capacity and power input; b) Entering indoor unit air temperature capacity and power input; c) combination ratio capacity and power input; d) Heating mode pipe length capacity correction.

1.6 SUBMITTALS

A. Submit unit performance data including capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

E. VRF outdoor unit submittal data must include salt spray test results. Salt spray test shall be conducted per ASTM B-117 standard. The test shall be performed for a minimum of 1000 hours.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data, troubleshooting guides, service manuals, and engineering manuals.

B. Provide the owner with the manufacturer’s VRF system service diagnostics software

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 WARRANTY

A. Provide one year parts warranty and seven (7) year compressor to the owner from date of installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: LG

B. Acceptable standards shall be supplied based upon the performance characteristics and features of the LG model number(s) specified, LG model families specified and as otherwise specified herein. Alternate suppliers shall request permission to bid, in writing, to the engineer at least 10 days prior to the bid date. This request by the contractor to bid an alternate supplier to the basis of design, listed or not listed, shall not relieve the contractor of supplying all materials, options, controls, sequences, efficiencies and intents of the original specifications written or implied by LG model number or model family or as otherwise specified. The contractor will be responsible for any additional cost resulting from the alternate supplier.

2.2 GENERAL

A. Variable Refrigerant Flow (VRF) HVAC system shall be a variable capacity, direct expansion (DX) heat recovery or heat pump engineered system.

B. Water source systems:

1. The water source unit shall consist of one or more cabinet(s) connected through common refrigerant piping, with built-in refrigerant to water heat exchanger for integration with field provided boiler/geothermal heat sink systems. Each water source system shall have (1) inverter compressor. Each system shall be connected to multiple indoor evaporator units refrigerant piping and integrated system controls. Each indoor unit shall be capable of providing individual zone control.

C. Air source systems:

1. The outdoor unit shall consist of one or more frames connected through a common 2-pipe Heat Pump or 3-pipe Heat Recovery refrigerant piping network and control communication wiring. Each system shall have single or multiple, inverter compressor(s). Each system shall be connected to multiple indoor units (ducted, non-ducted or mixed combinations) through a common refrigerant piping network and integrated system controls and communication network. Each indoor unit shall be controlled individually or as a group.

D. Heat recovery systems shall be capable of simultaneous heating and cooling individual zone(s).

2.3 LG MULTI V WATER IV VRF HEAT RECOVERY SYSTEM (6 TO 48 TONS)

A. Water source Unit shall be capable of the following operating ambient range.

1. Heat Recovery System
   a. Cooling and simultaneous mode
      1) Entering water range temperature: 23°F to 113°F

   b. Heating mode
      1) Entering water range temperature: 23°F to 113°F

2. Geothermal operating range: 23°F (Heating only)

B. General

1. The air-conditioning system shall use R410A refrigerant.

2. Each system shall have one, two or three water source units.

3. Dual and triple frame configurations shall be field piped together using manufacturer's designed and supplied Y-branch kit and field provided interconnecting pipe to form a common refrigerant circuit.

4. Refrigerant circuit configuration for Heat Recovery System

   a. The refrigerant circuit shall be constructed using field provided copper pipe together with manufacturer supplied Heat Recovery unit(s) connected to Y- branches or Headers fittings connected to multiple (ducted, non-ducted or combination thereof) indoor units to effectively and efficiently distribute refrigerant between system components.
   b. Each refrigerant pipe, y-branch, header kit and refrigerant specialties shall be individually insulated with no air gaps. All joints shall be glued and sealed.

5. Water circuit for heat recovery system

   a. All water piping between the water source unit(s) and the boiler/cooling tower or geothermal field shall be supplied and installed by the installing contractor with all accessories and water piping specialties required to complete the circuit.
   b. Flow of water shall be monitored by a field supplied flow switch connected to water source unit safety controls to prevent operation of the water source unit when there is insufficient water flow through heat exchanger.

6. Factory installed microprocessor controls in the water source unit, HR unit(s), and indoor unit(s) shall perform functions to efficiently operate the VRF system and communicate in a daisy chain configuration between the water source unit, the HR unit(s) and indoor unit(s) via RS485.

7. The system shall have the ability to accept connection up to 64 indoor units.

8. The maximum allowable system combination ratio shall be 130%. Systems designed with combination ratio above 130% are not acceptable.

9. The total nominal capacity of all indoor units shall be no less than 50% and no more than 130% of outdoor unit's nominal capacity to ensure the VRF system will have sufficient capacity to meet the building's cooling and heating load at design day weather conditions.

10. The unit shall be shipped from the factory fully assembled including internal refrigerant piping, compressor, contacts, relay(s), power and communications wiring necessary.

11. Each water source unit refrigeration circuit shall have the following components:

    a. Refrigerant strainer
    b. Check valves
    c. Oil separator
    d. Accumulator
    e. Hot gas bypass valve
    f. 4-way reversing valve
    g. Electronic expansion valve(s)
    h. Sub-cooler
    i. High and low side Schrader valves
    j. Service valves

12. Variable Water Flow Control Kit accessory shall be installed. Variable Water Flow Control Kit allows connection to a field supplied modulating water valve that will vary the flow to the water source used based on compressor speed, saving pumping energy.

C. Piping Capabilities

1. The system shall be capable of operating at an elevation difference of up to 164 feet above or below the lowest or highest indoor unit respectively.

2. The system shall be capable of operating with up to 1640 equivalent length feet of interconnecting liquid line refrigerant pipe in the network.

3. The system shall be capable of operating with up to 656 actual feet or 738 equivalent length feet of liquid line refrigerant pipe spanning between the outdoor unit and farthest indoor unit.

4. The elevation difference between two indoor units shall not exceed 131 feet for heat pump.

D. Oil Management

1. The system shall have Hi-POR (High Pressure Oil Return) to ensure a consistent film of oil on all moving compressor parts at low speed. Oil is returned to compressor through a separate oil injection pipe.

2. The system shall be provided with a centrifugal oil separator designed to extract oil from the oil/refrigerant gas stream leaving the compressor and return the extracted oil to the compressor oil sump.

3. The system shall have an oil level sensor in the compressor to provide direct oil level sensing.

4. The system shall only initiate an oil return cycle if the oil level is too low.

E. Cabinet

1. Water source unit cabinet shall be made of 20 gauge galvanized steel with a powder coated baked enamel finish.

2. Water source unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

3. All pipe connections, maintenance, and service access shall be from front side of the unit only. Unit designs that require service access or pipe connections through either side, top or back panels will not be acceptable.

4. Optionally, the cabinet shall be designed to also accept field provided refrigerant piping through the bottom of the unit.

5. A smaller service access panel, not larger than 4”x 8” shall be provided in the front panel to access the following with removing the front service panel:

   a. Service tool connection
   b. DIP switches
   c. Error code

6. Water connections shall be from the front of the water source unit.

F. Condenser

1. The water source unit shall be provided with a stainless steel plate type heat exchanger.

2. The heat exchanger shall remove/add heat between refrigerant and water.

3. The heat exchanger shall be protected with a field supplied (50Mesh or finer) strainer.

4. The system shall be provided with a field provided flow switch.

5. The unit shall have a factory installed water temperature safety switch to monitor excessive increase or decrease of inlet water temperature.

G. Compressor(s)

1. 460V Water Source Unit
   a. Each 6, 8, 10, 12, 14, 16 ton cabinet(s) shall be equipped with one hermetically sealed, High Side Shell (HSS), inverter driven, scroll compressor.
   b. Low Side Shell compressor(s) are not acceptable.

2. Each inverter driven, digitally scroll compressor shall be capable of operating in a frequency range from 20 Hz to 140 Hz with control in 1 Hz increments.

3. The compressor shall be provided with a full charge of Polyvinyl Ether (PVE) oil from the factory.

4. The compressor bearing(s) shall be Teflon™ coated.

5. The compressor(s) shall be mounted on rubber isolation grommets.

6. The compressor(s) shall be wrapped with heat resistant, sound attenuating blanket.

7. Inverter compressor(s) safeties shall include a minimum of:
    a. High Pressure switch
    b. Over-current /under current protection
    c. Phase failure
    d. Phase reversal

H. Sound Levels

1. Each cabinet shall be rated with a sound level not to exceed 62 dB(A) when tested in an anechoic chamber under ISO3745 standard.

I. Sensors

1. Each unit cabinet shall be equipped with
    a. Suction temperature thermistor
    b. Discharge temperature thermistor
    c. High Pressure switch
    d. High Pressure sensor
    e. Low Pressure sensor
    f. Water source temperature sensor
    g. Heat exchanger temperature sensor

2.4 HEAT RECOVERY UNIT (HRU)

A. General

1. HR unit shall be designed and manufactured by the same manufacturer of VRF indoor units and water source units.

2. HR unit casing shall be made with galvanized steel.

3. HR unit shall require 208-230V/1-phase/60Hz power supply.

4. HR Unit shall be an intermediate refrigerant control device between the water source unit and the indoor units to control the systems simultaneous cooling and heating operation.

5. HR unit shall be engineered to work with a have a three pipe VRF system comprising of

    a. High Pressure Vapor Pipe
    b. Low Pressure Vapor Pipe
    c. Liquid Pipe

6. HR unit shall be designed to be piped in series with the use of Y-branch or header fittings.

7. HR unit shall have 2, 3, 4, or 6 ports.

8. Each port shall be capable of operating in cooling or heating independently regardless of the operating mode of any other port on the HR unit or in the system.

9. Each port shall be capable of connecting from 2, 3, 4, or 6 indoor units to a maximum nominal capacity of 54MBh.

10. Maximum nominal capacity per HR unit shall not exceed 191MBh.

11. HR unit shall be internally piped, wired, assembled and run tested at the factory.

12. HR unit shall be designed for installation in a conditioned environment.

13. HR unit shall have a liquid bypass valve.

14. HR unit shall have (2) two-position solenoid valves per port.

15. HR unit shall have a balancing valve to control the pressure between the high pressure and low pressure pipe during mode switching.

16. HR unit shall have an electronic expansion valve for subcooling.

17. HR unit shall not require a condensate drain.

18. HR unit shall be internally insulated.

19. All field refrigerant lines between water source unit and HR unit and from HR unit to indoor unit shall be field insulated.

20. The HR unit shall not exceed a net weight of 53 lbs.

21. The system shall be designed to accommodate 16 HR units connected to Heat Recovery units piped in single series string.

22. A single series pipe string of 1 to 16 HR units shall be capable of serving indoor units with a total nominal capacity of 192 MBH

B. Piping Capabilities

1. The acceptable piping length between HR unit(s) and indoor unit(s) shall be 131 equivalent length feet.

2. The acceptable elevation difference between each HR unit and each indoor unit and between (2) HR units shall not exceed 131 feet.

C. Controls

1. HR unit(s) shall have factory installed unit mounted control boards and integral microprocessor to communicate with other devices in the VRF system.

2. HR unit shall be connected to the water source unit and indoor unit in a control circuit with 24VDC using a 2-conductor shielded cable for RS485 daisy chain communication.

3. The VRF manufacturer shall provide published documentation that specifically allows the installation of field provided isolation valves on all pipes connected to the Heat Recovery unit to allow the servicing of HR units refrigerant circuit or the replacement of HR unit without evacuating the balance of the piping system

2.5 LG MULTI V S HEAT PUMP (2 TO 5 TONS)

A. General

1. Variable Refrigerant Flow (VRF) HVAC outdoor unit shall be a variable capacity, direct expansion (DX), Heat Pump engineered system. The VRF system shall consist of a single frame outdoor unit, interconnecting piping, multiple indoor units (ducted, non-ducted or mixed combinations), onboard, self-contained, stand-alone communication and controls.

2. LG Multi V S outdoor unit shall be manufactured as a Heat Pump model capable of heating or cooling. Heat pump models shall be able to heat OR cool separate thermal zones.

3. Heat pump systems shall require two pipes, simultaneous heating and cooling shall not be supported. One pipe shall support bidirectional flow single state liquid refrigerant. The other pipe shall support bidirectional flow of single state refrigerant gas. In heating mode, the gas shall be superheated high pressure. In cooling mode the gas shall be low pressure, low temperature.

4. Heat pump outdoor units shall be designed to communicate directly with all VRF indoor units manufactured by the same supplier over a field supplied stranded, twisted and shielded pair wire. Systems requiring intermediary protocol translators, signal boosters, integration with a third party building management systems (BMS) or any other device required for communication possible shall not be accepted.

5. Indoor unit connectivity: The system shall be designed to accept connection up to 12 indoor units of various configurations and capacity.

6. Combination Ratio (CR) is defined as sum of nominal cooling capacity of proposed indoor units/nominal cooling capacity of the outdoor unit. The maximum allowable system combination ratio shall be 130%. Systems designed with combination ratio above 130% are not acceptable. The total nominal capacity of all indoor units shall be no less than 50% and no more than 130% of outdoor unit's nominal capacity.

B. Outdoor Unit

1. The unit shall be shipped from the factory fully assembled including internal refrigerant piping, inverter driven compressor, controls, contacts, relay(s), fan(s), power and communication wiring.

2. The refrigerant shall be R410A.

3. Voltage specifications: 208-230V/60Hz/1-phase (Phase to ground tolerance ±10%)

4. All outdoor units, regardless of the Heat Pump or Heat Recovery models, shall be the same generation and provide with most up to date firmware version at the time of delivery. Manufacturers commissioning agents shall assure the owner in the commissioning report that the latest software version.

5. If the specifications include both heat pump and heat recovery outdoor models, the manufacturer shall provide the most recent generation equipment only. Old stock or obsolete models will not be accepted. Products purchased over the internet and not from the manufacturer's authorized local mechanical representative or authorized distributer will not be accepted.

6. The VRF systems shall be capable of providing continuous compressor operation over the required ambient operating range. Submittal or technical performance data that indicates the required operating ambient range includes data points that do not guarantee continuous compressor operation, noted as reference data, or footnoted as such shall not be accepted. The required ambient operating range is defined as follows:

    a. Cooling
        1) Heat Pump System w/ Low Ambient Kit: -9.9°F DB to 122°F DB

b. Heating
   1) Heat Pump: - 4°F WB to 61°F WB

7. Operational Sound Level.

   a. Manufacturers' published data shall include sound pressure and sound power levels.

      1) Sound pressure level shall not exceed 52 dB (A) during cooling operation for Heat Pump outdoor units when tested in an anechoic chamber under ISO3745 standard. Other testing conditions shall not be allowed.
      2) Sound power level shall not exceed 69 dB (A) when tested in an anechoic chamber under ISO3745 standard. Other testing conditions shall not be allowed.

8. Cabinet

   a. Outdoor unit cabinet shall be made of 22 gauge, galvanized steel with a weather and corrosion resistant enamel finish. Outdoor unit cabinet finish shall be tested in accordance with ASTM B-117 salt spray surface scratch test (SST) procedure for a minimum of 1000 hours.

   b. The cabinet shall have piping knockouts to allow refrigerant piping to be connected at the front, right side, or through the bottom of the unit.

   c. A removable service panel shall be provided to access the following internal components:

      1) Service tool connection
      2) DIP switches
      3) Main microprocessor
      4) Inverter PCB

9. Compressor

   a. The compressor shall be a high efficiency high-side shell rotary hermetic design. Bearing shall be manufactured using high lubricity material. Compressor shall be factory charged with Polyvinyl Ether (PVE) oil. Single or dual speed compressors charged with Polyolester oil (POE) shall not be acceptable. Compressor inverter drive shall allow modulation from 20Hz to 90Hz with control in 1.0 Hz increments depending on the nominal capacity.

10. Outdoor Unit Coil

   a. Outdoor unit coil shall be comprised of aluminum fins mechanically bonded to copper tubing with inner surfaces having a riffling treatment to expand the total surface of the tube interior

   b. The aluminum fin heat transfer surfaces shall have factory applied corrosion resistant GoldFin™ coating. The coils coating shall be tested per ASTM B-117 standard. The test shall be performed for a minimum of 1000 hours. The outdoor unit coil shall have a minimum of 2 rows.

   c. The outdoor unit coil shall have a minimum of 14 Fins per Inch (FPI).

   d. The outdoor unit coil shall be protected with a heavy gauge steel wire guard.

   e. The coil guard shall have a baked enamel finish.

   f. The outdoor unit coil, all indoor units and pipe network shall be field tested to a minimum pressure of 550 psig. Manufacturers that do not specify and/or allow field testing at 550 psig shall not be allowed.

g. The cabinet shall have a factory installed coil guard.

11. Fan Assembly

a. All units shall be equipped with direct drive, variable speed, axial flow fan(s) with Brushless Digitally Controlled (BLDC) motor(s) with a horizontal air discharge.

b. The fan(s) blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.

c. The fan motor(s) shall be equipped with permanently lubricated bearings.

d. The fan motor(s) shall be variable speed with an operating speed range of 0 to 850 RPM in cooling mode and heating mode. The fan(s) shall have a guard(s) to help prevent contact with moving parts.

e. The fan control shall have a function setting to remove excess snow.

12. Outdoor unit Refrigerant Circuit

a. The outdoor unit refrigeration circuit at a minimum shall include the following components:

1) Refrigerant strainer(s)
2) Check valve(s)
3) Inverter driven, high pressure shell compressor
4) Oil separator
5) Accumulator
6) 4-way reversing valve
7) Electronic expansion valve(s)
8) Double spiral tube sub-cooler and EEV
9) High/low Schrader valve service ports with caps
10) High/low service valves
11) Threaded fusible plug
12) High pressure switch

b. The VRF outdoor unit shall use the sub-cooler while operating in cooling mode to sub-cool liquid refrigerant coming from the condenser coil well below saturation temperature to ensure that refrigerant remains in 100% liquid state when it reaches the farthest indoor unit's EEV valve. Sub-cooler operation algorithm must be able to vary the amount of sub-cooling from 4˚F to 30˚F. The amount of sub-cooling shall be minimized at all times to maximize efficiency by not overcooling the liquid.

13. Defrost Operations

a. The outdoor unit(s) shall be capable of auto defrost operation to melt accumulated frost off the outdoor unit heat exchanger. The defrost cycle control shall monitor the outdoor ambient temperature and outdoor unit heat exchanger surface temperature.

b. The frequency of operating the defrost cycle shall be determined by the system's ability to maintain sufficient system head pressure to deliver comfortable warm air to the building.

14. Microprocessor Control

a. Factory installed microprocessor control in the outdoor unit, heat recovery unit(s), and indoor unit(s) shall communicate using the same protocol. Translators of any kind are not allowed. Communication between VRF system components shall be via field supplied stranded, shielded and twisted wire pair

in a RS 485 network configuration. Integrated control system shall perform functions to optimize the operation of the VRF system.

b. Power and communication interruption: The system shall be capable of performing continuous operation when an individual or several indoor units are being serviced; communication wire cut or power to indoor unit is disconnected. Systems that alarm and/or shut down because of a lack of power to any number of indoor units shall not be acceptable or allowed.

c. Main microprocessor shall include human interface capability that provides a visual code that reports systems operation status. If any malfunction occurs, or system is operating with an unstable refrigerant cycle sensors shall report the malfunction to the visual display.

d. Main processor shall provide the commissioning agent the ability to customize the VRF systems operation based on the environment in which it is installed. Customization function to include defrost operation, modifying target superheat, sub-cooling, low pressure and high pressure values , and invoke other algorithms such as smart load control to optimize system operating efficiency. The main processor board shall include the following features:

1) Service tool connection
2) DIP switches
3) Auto addressing
4) Error codes
5) Main microprocessor
6) Inverter PCB

15. Outdoor unit microprocessor shall have the capability of reporting malfunction and diagnostic codes to remote control devices such as the VRF manufacturer's central controller, Zone controllers, and Building Management System (BMS).

16. Sensors

a. Each outdoor unit module shall have

1) Suction temperature sensor
2) Discharge temperature sensor
3) High Pressure sensor
4) Low Pressure sensor
5) Outdoor temperature sensor
6) Outdoor unit heat exchanger temperature sensors

17. Wi-Fi communication: The outdoor unit shall be Wi-Fi capable. Wi-Fi shall allow service or maintenance personal access to the operating system diagnostics and monitoring functions, via the manufacturer's provided maintenance and diagnostic software over a mobile device or personal computer. Communication between devices shall include: 1) Real-time system operation monitoring with the ability to capture all system operating data for a field determined period of time into a downloadable csv file format to a wireless connected device; 2) Collection of point in time (snapshot) information including all current outdoor unit operating conditions and each indoor unit, system EEV and solenoid valves, sensors, compressor speed, and refrigerant operating pressures. Systems that require computers with a hard wire only connection or other devices to collect, review or record operating conditions shall not be allowed.

18. Third Party Controls platform Integration

a. The VRF system manufacturer's central controls platform shall be able to communicate with third party building management systems (BMS) via BACnet™ IP, Modbus TCP, or LonWorks™ protocol allowing third party BMS system control and/or monitoring of the LG air conditioning and heating

system. See controls specification for more detailed description of integration and points to be controlled and monitored.

b. The VRF system manufacturer shall have available off-the shelf devices that allows on/off binary interfaces between third party ancillary devices such as fans, door locks, photo eyes, key card switches, motion sensors, exhaust fans, dampers, and a single (or group of) VRF indoor units. Indoor units shall have the ability to start/stop the third party device, receive a contact closure signal from the third party device, or have the third party device change the operating conditions of the VRF indoor unit. Operating conditions shall include one or more of the following indoor unit functions: fan speed, fan on/off, thermal on/off cooling or heating, or indoor unit start/stop.

19. Refrigerant System Cycle and Control

a. The refrigerant cycle operation core logic shall establish and maintain target evaporating temperature (Te) to be constant in cooling mode and condensing temperature (Tc) constant in heating mode and maintain system stable operation while operating compressors across the range of environmental conditions guaranteeing continuous compressor operation. VRF system core logic shall be able to dynamically modify the target evaporator and condenser temperatures to maximize energy savings when system is operating at part load conditions.

b. Flexible Capacity Control (Demand limiting): The flexible capacity control (FCC) optional controller provides third party control of the power consumption of the VRF system. The FCC controller shall be able to accept up to five (5) separate inputs from a third party device. Demand limiting shall provide up to eight (8) steps of capacity control in response to a binary signal from a third party BMS system or multistep signal from the local power company.

c. Smart load control: Smart load control operation shall enhance energy savings and increase indoor comfort by monitoring the real time ambient temperature, real time weighted mean average building load, and the outdoor relativity humidity (if enabled).

1) Smart load control shall be a field selectable, consisting of three operating algorithm, selectable at the time of commissioning or at any other time:

a) At initial start up
i. The system shall be influenced by any one of the chosen algorithm
ii. Off mode: Smart load control algorithm shall be in off mode
iii. Smooth mode: Smart Load control shall maximize energy savings. The rate of temperature change shall be insignificant.
iv. Normal Mode: Smart Load Control shall balance the rate of temperature change with energy consumed.
v. Peak Mode: Smart Load shall quickly cool/heat the building. The energy consumption shall not be the priority in this mode.

b) For the first 20 minutes after the initial startup, the Smart Load Control will influence the outdoor unit operation for the chosen algorithm. This operation will be available at every start up.

2) After 20 minutes of compressor operation

a) Smart Load control will maintain the chosen logic and system will operate with the same core logic.

3) Smart Load Control monitors two or three inputs:

a) Weighted mean average building load

b) Outdoor ambient dry bulb temperature
c) Outdoor ambient relative humidity (when enabled)

4) Enhance energy savings

a) Cooling Mode:
i. Smart Load Control raises the system target low pressure during off-peak operation.
ii. Raising the operating low pressure shall reduce the compressor lift; reduce compressor's speed and power consumption.

b) Heating Mode

i. Smart Load control shall lower the system target high pressure during off-peak heating operation.
ii. Lowering the operating high pressure target shall reduce compressor lift, reduce compressor speed and power consumption.
iii. Energy saved is in addition to the energy savings basic VRF load control provides.

5) Increased indoor comfort

a) Smart Load control shall use one (or two) sensors to measure changing outdoor weather conditions and shall prepare the VRF system to operate under the revised weather conditions. This operation shall be activated before the changed ambient conditions have an impact on indoor units.

C. Field Supplied Refrigerant Piping Design Parameters

1. General

a. Refrigerant circuit configuration for heat pump and heat recovery system:

1) The refrigerant circuit shall be constructed using field provided ACR copper, de-hydrated, refrigerant rated copper pipe, piped together with manufacturer supplied heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump or heat recovery mode operations or simultaneous heating and cooling operation of the VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions to any other componets or materials also in use in the system and shall be installed per manufactures instructions. LG does not endorse, approve or recommend any mechancial fitting or pipe manufacture.

2) All refrigerant pipe, y-branches, elbows and valves shall be individually insulated with no air gaps. Insulation R-value (thickness) shall not be less than the minimum called for by the local building code, local energy code or as a minimum per manufacture installation requirements. In no case shall the insulation be allowed to be compressed at any point in the system.

3) All joints shall be glued and sealed per insulation manufactures instructions to make an air tight assembly.

b. The outdoor unit shall be capable of operating at an elevation difference of up to of 164 feet above or 131 feet below the lowest or highest indoor unit respectively without the requirement of field installed sub-cooler or other forms of performance enhancing booster devices.

c. The outdoor unit shall be capable of operating with up to 984 equivalent length feet of interconnecting liquid line refrigerant pipe in the network.

d. The outdoor unit shall be capable of operating with up to 492 actual feet or 574 equivalent length feet of liquid line refrigerant pipe spanning between outdoor unit and farthest indoor unit.

e. The elevation difference between the highest and lowest indoor units shall not exceed 49 feet.

f. The piping system shall be designed with pipe expansion and contraction possibilities in mind. Required expansion devices shall be field designed, supplied and installed based on proper evaluation of the proposed piping design. In addition to these requirements, the piping system installation must conform to the VRF equipment manufacturer's published guidelines.

g. The installation of pipe hangers, supports, insulation, and in general the methods chosen to attach the pipe system to the structure must allow for expansion and contraction of the piping system and shall not interfere with that movement.

2.6 LG MULTI V 5 HEAT PUMP (6 TO 42 TONS)

A. General

1. Variable Refrigerant Flow (VRF) HVAC system shall be a variable capacity, direct expansion (DX) field selectable Heat Pump engineered system within a single cabinet. The outdoor unit shall consist of one or more frames connected through a common 2-pipe Heat Pump refrigerant piping network and control communication wiring. Each system shall have single or multiple, inverter compressor(s). Each system shall be connected to multiple indoor units (ducted, non-ducted or mixed combinations) through a common refrigerant piping network and integrated system controls and communication network. Each indoor unit shall be controlled individually or as a group.

2. All three-phase outdoor units shall be from the same product design. Mixing of different product designs, families, or product lines are not acceptable.

3. All three-phase VRF heat pump outdoor units shall be from the same product development generation. Mixing of outdoor units from different development generations is not acceptable

4. The VRF systems shall be capable of providing continuous compressor operation over the required ambient operating range. VRF systems that provide possible, but don't guarantee continuous compressor operation over the required ambient operating range, will not be accepted. Submittal that states performance data is reference data, data that is for reference only, or that is footnoted as such shall not be accepted.

5. Outdoor Unit shall be capable of continuous compressor operation between the following operating ambient air conditions, operation outside of these conditions are possible and may involve non-continuous operations.

6. Operating Ambient Air Conditions:

   a. Heat Pump System w/ Low Ambient Kit

      1) Cooling: -9.9°F DB to 122°F DB
      2) Heating: -13°F WB to 61°F WB

7. The air-conditioning system shall use R410A refrigerant.

8. The system shall be capable of an automatic variable refrigerant charge function for use in both the heat mode and cool mode to ensure the proper amount of circulating refrigerant is in the system. Manufactures that cannot control, in real time, the amount of circulating refrigerant to ensure optimal system operation

year-round shall not be allowed.

9. Each system shall consist of one, two or three air source outdoor unit modules conjoined together in the field to result in the capacity specified elsewhere in these documents.

10. System shall employ self-diagnostics function to identify any malfunctions and provide type and location of malfunctions via fault alarms.

11. Refrigerant Circuit Configuration for Heat Pump Systems: The refrigerant circuit shall be constructed using field provided ACR copper, de-hydrated, refrigerant rated copper pipe, piped together with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump or Heat Recovery mode operations or simultaneous heating and cooling operation of the VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions to any other components or materials also in use in the system and shall be installed per manufacturer's instructions. LG does not endorse, approve or recommend any mechanical fitting or pipe manufacturer.

12. All refrigerant pipe, y-branches, elbows and valves shall be individually insulated with no air gaps. Insulation R-value (thickness) shall not be less than the minimum called for by the local building code, local energy code or as a minimum per manufacture installation requirements. In no case shall the insulation be allowed to be compressed at any point in the system.

    a. All joints shall be glued and sealed per insulation manufactures instructions to make an air tight assembly.

13. Factory installed microprocessor controls in the outdoor unit(s), heat recovery unit(s), and indoor unit(s) shall perform functions to optimize the operation of the VRF system and communicate in a daisy chain configuration between outdoor unit and heat recovery unit(s) and indoor unit(s) via RS485 network. Controls shall also be available to control other building systems as required from the VRF control system. DIO/AIO capabilities shall be available as well as a central controller to perform operation changes, schedules and other duties as required by this specification. Addition of separate building control system shall not be required. Other control devices and sequences shall be as specified in other sections of this project specification.

14. Inverter PCB Cooling: Cooling of the inverter PCB shall be conducted by way of high pressure, sub-cooled liquid refrigerant via heat exchanger attached to rear side of inverter PCB. The full capacity flow of refrigerant shall pass though the heat exchangers to maximize the cooling effect of the PCBs and to aid in the evaporation process and capacity of the outdoor coil during the heating mode. The recovered heat of the PCBs must be used to enhance the overall heating process, other uses or dissipation of heat to ambient shall not be permitted.

15. Compressor Control: Fuzzy control logic shall establish and maintain target evaporating temperature (Te) to be constant on cooling mode and condensing temperature (Tc) constant on heating mode by Fuzzy control logic to ensure the stable system performance. Other compressor control capabilities shall be available via special function controls as noted elsewhere in this specification.

16. Initial Test Run (ITR) (Heating or Cooling) / Fault Detection Diagnosis (FDD) Code: This control mode shall monitor and display positive or negative results of system initial startup and commissioning. Heating or Cooling ITR mode will be automatically selected. It shall monitor the following, but not be limited to, refrigerant quantity charge, auto-charge, stable operations, connection ratios, indoor unit status, error status, and number of indoor units connected. This control mode shall not replace the system error monitoring control system.

17. Integration: Each system shall be able to integrate via BACnet™ IP gateway. This gateway converts between BACnet™ IP or Modbus TCP protocol, and RS-485 LGAP (LG Aircon protocol) allowing third party control and monitoring of the LG A/C system, or LonWorks™ gateways. See controls specification for more detailed description of integration and points to be controlled and monitored.

18. Advanced Smart Load Control: Smart load control operation shall be available at any time during or after system commissioning. Smart Load Control shall be initiated by outdoor air temperature and or relativity humidity as sensed at the outdoor unit and shall automatically adjust the evaporator target (condenser target for heat) pressure/temperature that the system will operate to in order to precisely load match the system to the building load as the outdoor and/or the indoor ambient temperature increases or decreases. By varying the compression ratios of the system and increasing the operating efficiencies, comfort and reducing energy consumption by adjusting the compressor lifts, the system shall poll all indoor units' data and dry bulb temperature in real time and apply its algorithm to determine the optimal evaporating temperature to satisfy varying loads. Systems that rely on the worst performing zone to reset the system conditions shall not be sufficient and shall not be allowed.

19. Wi-Fi Communication: The outdoor unit shall be Wi-Fi enabled and capable. Wi-Fi shall allow service or maintenance personal access to the complete operating system, via LGMV mobile, without need of tools other than smart phone or tablet. Active live system review, collection of all system data for a field determined duration presented in a .csv file format or collection of all operating conditions, including all indoor units, valves, sensors, compressor speeds, refrigerant pressures, etc., by snapshot of conditions and placing that snapshot into a power point slide to be reviewed at another time. Systems that require computers, hard wire only connection or other devices to collect, review or record operating conditions shall not be allowed.

20. Indoor Unit Connectivity: The system shall be designed to accept connection up to 64 indoor units of various configuration and capacity, depending on the capacity of the system.

21. Power and Communication Interruption: The system shall be capable of performing continuous operation when an individual or several indoor units are being serviced; communication wire cut or power to indoor unit is disconnected. Systems that alarm and/or shut down because of a lack of power to any number of indoor units shall not be acceptable or allowed.

22. Connection Ratios: The maximum allowable system combination ratio shall be 130%. Systems designed with combination ratio above 130% are not acceptable. The total nominal capacity of all indoor units shall be no less than 50% and no more than 130% of outdoor unit's nominal capacity.

23. Intelligent Heat Mode: Intelligent heating shall be initiated via a field setting at the outdoor unit. Intelligent heating shall extend the heating operation by calculating the dew point of the outdoor coil surface using the outdoor units' temperature and humidity sensors to maintain the coil surface temperature above the ambient dew point minimizing frost build-up and delaying a defrost operation while maintaining indoor space temperature. This feature shall be capable of eliminating several defrost actions per day based on outdoor air temperature and humidity conditions.

24. Comfort Cooling Mode: Comfort cooling shall be initiated via a field setting at the outdoor unit during commissioning or anytime thereafter. Comfort cooling shall allow user to select all or some of the zones on a system to adjust automatically their evaporator temperatures, independent of other zones, based on the impending total loads of that zone determined by using the zone controller temperature sensor.

25. The outdoor unit refrigerant circuit shall employ for safety a threaded fusible plug.

26. The unit shall be shipped from the factory fully assembled including internal refrigerant piping, inverter driven compressor(s), controls, temperature sensor, humidity sensor, contacts, relay(s), fans, power and communications wiring as necessary to perform both Heat Pump and Heat recovery operations.

27. Each outdoor unit refrigeration circuit shall include, but not limited to, the following components:

    a. Refrigerant strainer(s)
    b. Check valve(s)
    c. Inverter driven, medium pressure vapor injection, high pressure shell compressors
    d. Liquid refrigerant cooled inverter PCB
    e. Oil separator(s)
    f. Accumulator /controlled volume receiver(s)
    g. 4-way reversing valve(s)
    h. Vapor injection valve(s)
    i. Variable path heat exchanger control valve(s)
    j. Oil balancing control
    k. Oil Level sensor(s)
    l. Electronic expansion valve(s)
    m. Sub-cooler (s)
    n. Vapor Injection Valve(s)
    o. High and low side Schrader valve service ports with caps
    p. Service valves
    q. Factory supplied refrigerant charge, pounds.

B. Refrigerant Flow Control

1. Variable Path Heat Exchanger: System shall have a variable flow and path outdoor heat exchanger function to vary the refrigerant flow and volume and path. Control of the variable path circuits shall be based on system operating mode and operating conditions as targeted to manage the efficiency and minimize or maximize the circulating volume of the operating fluids of the system.

2. Vapor Injection: System shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor.

3. Active Refrigerant Control: System shall have an active refrigerant control and multi section accumulator-receiver that dynamically changes the volume of refrigerant circulating in the system based on operating mode and operating conditions to ensure maximum system performance and efficiency.

4. Compressor Design: The compressor design shall be of the high pressure shell scroll type where the internal pressure below the suction valves of the compressor shall be at the same high pressure and high temperature. The motor shall be cooled by high pressure gas at temperatures above saturation conditions and minimize the mixing of refrigerant liquid with oil in the sump. The system shall employ a high pressure oil return method returning recovered oil from the oil separator directly into the oil sump of the compressor; oil shall not be allowed to return via the suction line. Bearing surfaces are continually coated with oil. The compressor shall employ an Aero-bearing constructed with high lubricity materials increasing operation time in case of low sump oil level. Compressor shall have a nominal operating range from 15Hz to 150 Hz.

5. The VRF outdoor unit shall include a factory provided and mounted sub-cooler assembly consisting of a shell and tube-type sub-cooling heat exchanger and EEV providing refrigerant sub-cooling modulation control by fuzzy logic of EEV and by mode of operation to provide capacity and efficiency as required. Brazed plate heat exchangers shall not be allowed for this function.

6. VRF Systems with Onboard Alternate Operating Mode Selection Capability

    a. All VRF systems which provide field selectable Alternate Operating Modes, for example, High Heat or High Ambient Cooling, published data tables must be available to the public for all modes offered.

b. Acceptable Alternate Operating Modes must ship with all models of the VRF product offering and must be factory embedded. Custom factory or field modifications to factory provided algorithms created to meet scheduled requirements are not acceptable.

c. Provide a copy of instructions required to set the Alternate Operation Mode with the initial submittal.

d. For systems that provide field selectable Alternate Operating Modes, ALL technical data provided in the submittal data sheets showing product rated condition performance data, must also provide separate data sheets that show product performance data at each of the field selectable Alternate Operating Modes available. Capacity, power input, and acoustic performance data for each mode offered shall be reported separately. Mixing of ODU, IDU, or VRF system performance capability operating in one mode with for example the power consumption, sound power rating, or electrical requirements of the same system operating in another mode is not acceptable.

C. Field Supplied Refrigerant Piping Design Parameters

1. The outdoor unit shall be capable of operating at an elevation difference of up to 360 feet above or below the lowest or highest indoor unit respectively without the requirement of field installed subcooler or other forms of performance enhancing booster devices.

2. The outdoor unit shall be capable of operating with up to 3280 equivalent length feet of interconnecting liquid line refrigerant pipe in the network.

3. The outdoor unit shall be capable of operating with up to 656 actual feet or 738 equivalent length feet of liquid line refrigerant pipe spanning between outdoor unit and farthest indoor unit.

4. The piping system shall be designed with pipe expansion and contraction possibilities in mind. Required expansion devices shall be field designed, supplied and installed based on proper evaluation of the proposed piping design. In addition to these requirements, the piping system installation must conform to the VRF equipment manufacturer's published guidelines.

5. The installation of pipe hangers, supports, insulation, and in general the methods chosen to attach the pipe system to the structure must allow for expansion and contraction of the piping system and shall not interfere with that movement.

D. Defrost Operations

1. The outdoor unit(s) shall be capable of Intelligent defrost operation to melt accumulated frost, snow and ice that may have accumulated on the outdoor unit heat exchanger. The defrost cycle length and sequence shall be based on outdoor ambient temperatures, outdoor unit heat exchanger temperature, and various differential pressure variables. Intelligent Heating Mode, when outdoor unit humidistat is engaged, shall extend the normal heating sequences by adjusting the outdoor unit coil target temperature to be above the ambient dew point temperature delaying the need for defrost operations, so long as heating demand is being met.

2. Defrost Mode Selection: The outdoor unit shall be provided with a minimum of three field selectable defrost operation modes: Normal, Fast, or Forced.

a. Fast Defrost: Operation intended for use in areas of the country with mild winter temperatures and light to moderate humidity levels. The strategy minimizes defrost cycle frequency allowing frozen precipitation to build longer in between cycles. Minimum time between defrost cycles shall be 20 minutes. Intelligent Defrost shall choose between split coil/frame and full system methods based on current weather conditions to minimize energy consumption and maximize heating cycle time.

b. Normal Defrost: Operation intended for use in areas of the country that experience adverse winter

weather with periods of heavy winter precipitation and extremely low temperatures. This strategy shall maximize the systems heating performance and maintain operational efficiency. When the ambient temperature is either: a) above 32°F or b) below 32°F with the humidity level below 60% RH, Intelligent Defrost shall continue heating regardless of ice build-up on the coil until the quality of the heated air (i.e. discharge air temperature) decreases. At temperatures below 4°F, a defrost cycle shall occur every two hours to optimize system heating efficiency.

c. Forced Defrost: Operation shall be available for the service provider to test defrost operations at any weather condition and to manually clear frozen water from the outdoor coil surfaces.

3. Defrost Method Selection: The outdoor unit shall be provided with two field selectable defrost operation methods: Split Coil/Frame and Full System. Split Coil/Frame option provides continuous heating of the occupied space during defrost operation.

a. Split Coil/Frame method shall be available when Normal Defrost mode is selected. Split Coil method shall be available on all Heat Pump and Heat recovery single-frame VRF systems. Split Frame defrost shall be available on all Heat Pump and Heat recovery multi-frame outdoor units.

b. Split Coil method shall remove ice from the bottom half of the outdoor unit coil first for a maximum time of six minutes, then the top half for a maximum of six minutes. Next the bottom coil shall be heated again for an additional three minutes to remove any frozen water that may have dripped onto the lower coil during the top coil defrost operation.

c. When Split Coil/Frame method is selected, a Full System defrost shall occur every 1-9 (field selectable) defrost cycles to assure 100% of the frozen precipitation has been removed to maintain efficient performance.

d. Full System method shall be available as a field selectable option. All outdoor units located in areas of the country where large volumes of frozen precipitation are common, the commissioning agent shall be able to select the Full System only defrost method.

4. Indoor Unit Fan Operation During Defrost

a. During partial defrost operation indoor units operating in cooling or dry mode shall continue normal operation.

b. During partial defrost operation, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the defrost cycle.

c. During full system defrost operation indoor unit fans will cycle off and remain off during the remainder of the defrost cycle.

E. Oil Management

1. The system shall utilize a high pressure oil return system to ensure a consistent film of oil on all moving compressor parts at all points of operation. Oil is returned to compressor through a separate high pressure oil injection pipe directly into the oil sump. Oil returned to the compressor via the suction port of the compressor shall not be allowed.

2. Each compressor shall be provided with a high efficiency independent centrifugal cyclone type oil separator, designed to extract oil from the oil/refrigerant gas stream leaving the compressor.

3. The system shall have an oil level sensor in the compressor to provide direct oil level sensing data to the main controller. The sensor shall provide data to main outdoor unit PCB to start oil return mode and balance

oil levels between multiple compressors.

4. The system shall only initiate an oil return cycle if the sensed oil level is below oil level target values as determined by the microprocessor. The system shall display an error if the oil sensor signals low oil level for a period of 130 minutes or longer.

5. A default oil return algorithm shall automatically initiate the oil return mode if the system detects a failure of the oil sump sensor. A fault code shall be reported by the system.

6. Timed oil return operations or systems that do not directly monitor compressor oil level shall not be permitted.

7. Indoor Unit Fan Operation During Oil Return Cycle

   a. During oil return cycle indoor units operating in cooling or dry mode shall continue normal operation.

   b. During oil return, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the oil return cycle.

   c. During oil return cycle indoor unit fans will cycle off and remain off during oil return cycle while operating in all modes except 4.9.G.1 and 2.

F. Cabinet

1. Outdoor unit cabinet shall be made of 20 gauge galvanized steel with a weather and corrosion resistant enamel finish. Outdoor unit cabinet finish shall be tested in accordance with ASTM B-117 salt spray surface scratch test (SST) procedure for a minimum of 1000 hours.

2. The front panels of the outdoor units shall be removable type for access to internal components.

3. A smaller service access panel, not larger than 7” x 7” and secured by a maximum of (2) screws, shall be provided to access the following:

   a. Service tool connection
   b. DIP switches
   c. Auto addressing
   d. Error codes
   e. Main microprocessor
   f. Inverter PCB

4. The cabinet shall have piping knockouts to allow refrigerant piping to be connected at the front, right side, or through the bottom of the unit.

G. Fan Assembly

1. 6 ton frames shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a vertical air discharge.

2. 8 to 20 ton frames shall be equipped with two direct drive variable speed propeller fan(s) with BLDC motor(s) with a vertical air discharge.

3. The fan(s) blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material and incorporate biomimetic technology to enhance fan performance and reduce fan generated noise.

4. The fan(s) motor shall be equipped with permanently lubricated bearings.

5. The fan motor shall be variable speed with an operating speed range of 0-1150 RPM cooling mode and 0-1150 RPM heating mode.

6. The fan shall have a guard to help prevent contact with moving parts.

7. The cabinet shall have option to redirect the discharge air direction from vertical to horizontal with the addition of optional factory provided air guides.

8. The fan controller shall have a DIP switch setting to raise external static pressure of the fan up to 0.32 inch of W.C. to accommodate ducted installations.

9. The fan control shall have a function setting to remove excess snow automatically.

10. The fan control shall have a function setting to remove access dust and light debris from the outdoor unit and coil.

H. Outdoor Unit Coil

1. Shall be comprised of aluminum fins mechanically bonded to copper tubing and shall be four sided and 2 or 3 rows deep and 17 fins per inch.

2. The copper tubes shall have inner riffling to expand the total surface of the tube interior.

3. The aluminum fins shall have a factory applied Black Fin heat exchanger coating that is comprised of a highly corrosion resistant epoxy resin coating, 1.6-2.0 um thick, designed to perform in corrosive environments such as contaminated and humid conditions. The Black Fin heat exchanger protection shall include a Hydrophilic coating which minimizes moisture buildup on the fin heat exchanger. The “Black Fin” heat exchanger shall have been tested to the following conditions:

   a. ASTM B-117 Salt spray test – 1500 hours with no corrosion
   b. Acid salt test – 900 hours .02% corrosion
   c. ASM corrosion test – 3,000 hours. The Black Fin coating shall be certified by underwriters Laboratories and per ISO 21207. The above conditions shall establish the minimum allowable performance which all alternates must comply.

4. Shall be designed, built and provided by the VRF outdoor unit manufacturer.

5. The outdoor unit coil, all indoor units and pipe network shall be field tested to a minimum pressure of 550 psig. Manufacturers that do not specify and/or allow field testing at 550 psig shall not be allowed.

6. The outdoor unit coil for each cabinet shall have lanced aluminum fins with a maximum fin spacing of no more than 17 Fins per Inch (FPI). All the outdoor unit coils shall be a 2 or 3 rows consisting of staggered tubes for efficient air flow across the heat exchanger.

7. The cabinet shall have a factory installed coil guard.

I. Compressor(s)

1. Each 6, 8, 10 ton frames shall be equipped with a single hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressor.

2. 12, 14, 16, 18 and 20 ton frames shall be equipped with dual hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressors.

3. Each inverter driven, HSS scroll compressor shall be capable of operating from 12 Hz up to 150 Hz with control in 0.5 Hz increments in any and all modes (cooling, heating or simultaneous modes).

4. The compressor(s) shall be equipped with a 60 Watt crankcase heater controlled by oil temperature.

5. The compressor shall employ a factory metered charge of Polyvinyl Ether (PVE) oil.

6. The compressor shall be designed for a separate port for oil to be directly returned to the compressor oil sump.

7. The compressor bearing(s) shall have Teflon™ coating and shall be an aero type design using High lubricity materials.

8. The compressor(s) shall be protected with:

   a. High Pressure switch
   b. Over-current /under current protection
   c. Oil sump sensor
   d. Phase failure
   e. Phase reversal
   f. Compressor shall be capable of receiving injection of medium pressure gas at a point in the compression cycle where such injection shall allow a greater mass flow of refrigerant at lower outdoor ambient and achieving a higher heating capability. The VRF outdoor unit shall have published performance data for heating mode operation down to -13°F on both heat pump and heat recovery systems.

9. Standard, non-inverter driven compressors shall not be permitted nor shall a compressor without vapor injection or direct sump oil return capabilities.

J. Inverter Compressor Controller(s)

1. The VRF outdoor unit shall be provided with a separate inverter compressor controller PCB for each compressor. Inverter compressor controllers that host more than one compressor shall not be accepted.

2. The inverter compressor controller shall be designed and programmed to utilize the entire range of operation of the connected compressor during cooling cycle operation and/or heating cycle operation.

K. Operational Sound Levels

1. Each single frame outdoor unit shall be rated with an operational sound pressure level not to exceed as listed on below chart when tested in an anechoic chamber under ISO 3745 standard at the highest field selectable heating operating modes available. Such documentation shall be presented in all submittals, manufactures who elect to rate their equipment at other than tested in an anechoic chamber under ISO 3745 standard at the highest field selectable heating operating modes available and the highest field selectable conditions shall not be allowed. Rated sound pressure values shall not exceed 59 dBA.

2. A field setting shall be available to program the outdoor unit to reduce sound levels at night, when desired, to a selectable level while still able to meet building load requirement. This mode is available in both cooling and heating modes.

L. Sensors

1. Each outdoor unit module shall have:

a. Suction temperature sensor
b. Discharge temperature sensor
c. Oil level sensor
d. High Pressure sensor
e. Low Pressure sensor
f. Outdoor temperature sensor
g. Outdoor humidity sensor
h. Outdoor unit heat exchanger temperature sensors

2.7 LG DUCTED – HIGH STATIC EVAPORATORS

A. General

1. Unit shall be manufactured by LG.

2. Unit shall be designed to be installed for indoor application.

3. Unit shall be designed to mount fully concealed above the finished ceiling.

4. Unit shall have opening to supply air from front horizontal and a dedicated rear horizontal return.

5. The supply air shall be flanged for field installed ductwork that shall not exceed the external static pressure limitation of the unit.

B. Casing/Panel

1. Unit case shall be manufactured using galvanized steel plate.

2. The cold surfaces of the unit shall be covered internally with a coated polystyrene insulating material.

3. The cold surfaces of the unit shall be covered externally with sheet insulation made of Ethylene Propylene Diene Monomer (M-Class) (EPDM)

4. The external insulation shall be plenum rated and conform to ASTM Standard D-1418.

5. Unit shall be provided with hanger brackets designed to support the unit weight on four corners.

6. Hanger brackets shall have pre-punched holes designed to accept field supplied, all thread rod hangers.

C. Cabinet Assembly

1. Unit shall have horizontal supply air discharge outlets and a return air inlet

2. Unit shall be equipped with factory installed temperature thermistors for:

a. Return air
b. Refrigerant entering coil
c. Refrigerant leaving coil

3. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.

4. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.

5. Unit shall have the following functions as standard:

a. Self-diagnostic function
b. Auto addressing
c. Auto restart function
d. Auto changeover function (Heat Recovery system only)
e. Auto operation function
f. Child lock function
g. Forced operation
h. Dual thermistor control
i. Sleep mode
j. External static pressure (ESP) control
k. Dual set point control
l. Multiple aux heater applications
m. Filter life timer
n. External on/off input
o. Wi-Fi compatible
p. Auto fan operation
q. Leak detection logic

D. Fan Assembly

1. The unit shall have two direct drive Sirocco fans made of high strength ABS GP-2200 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fans shall be mounted on a common shaft.
4. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
5. The fan motor shall include thermal, overcurrent and low RPM protection.
6. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
7. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of three pre-programed fan speeds, each setting is also adjustable by field setting to compensate for a limited amount of additional resistance to airflow by adjusting the RPM of the fan motor.
8. In cooling mode, the indoor fan shall have the following settings; Low, Med, High, and Auto.
9. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
10. Each of the settings can be field adjusted from the factory setting (RPM/ESP).
11. Unit shall be designed for high speed air volume against an external static pressure of up to 0.98” water gauge, model dependent.

E. Filter Assembly

a. The return air inlet shall have a factory supplied removable, washable filter.

b. The filter access shall be from the rear of the unit.

F. Coil Assembly

1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.
3. Unit shall have a minimum two to three row coil, 19-21 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of HIPS (high impact polystyrene resin).
5. Unit shall include an installed and wired condensate drain lift pump capable of providing minimum 27.5 inch lift from bottom surface of the unit. The unit drain pan is supplied with a secondary drain port/plug allowing the pan to be gravity drained and serviced.
6. The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan, model dependent.

7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 550 psig.
9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be as per Section 23 07 00.

G. Microprocessor Control

1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode.
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core, stranded, twisted, and shielded communication cable.
3. The unit controls shall operate the indoor unit using one of the five operating modes:
   a. Auto changeover (Heat Recovery System only)
   b. Heating
   c. Cooling
   d. Dry
   e. Fan only
4. The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.
5. The unit shall be able to operate with the fan turned off during system cooling thermal off.
6. The unit shall be able to operate with a continuous fan setting.
7. The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.
8. The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.

H. Electrical
1. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS-485 daisy chain.

2.8 LG WALL MOUNTED - STANDARD

A. General

1. Unit shall be manufactured by LG.
2. Unit shall be designed to be installed for indoor application.
3. Unit shall be attached to an installation plate/bracket that secures unit to the wall.
4. The depth of the unit shall not exceed 8.25 inches.

B. Casing/Panel

1. Unit case shall be manufactured using Acrylonitrile Butadiene Styrene (ABS) polymeric resin and has a pearl white finish designed for mounting on a vertical surface and includes an installation mounting template and hanging bracket.

C. Cabinet Assembly

1. Unit shall have one supply air outlet and one return air inlet with a manual or motorized sweeping guide vane that automatically changes the direction of airflow from side-to-side and up-and-down.
2. Unit shall be equipped with factory installed temperature thermistors for:

    a. Return air
    b. Refrigerant entering coil
    c. Refrigerant leaving coil

3. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
4. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.
5. Unit shall have the following functions as standard:

    a. Self-diagnostic function
    b. Auto addressing
    c. Auto restart function
    d. Auto changeover function (Heat Recovery system only)
    e. Auto operation function
    f. Auto clean function
    g. Child lock function
    h. Forced operation
    i. Dual thermistor control
    j. Sleep mode
    k. Dual set point control
    l. Filter life timer
    m. External on/off control input
    n. Wi-Fi compatible
    o. Auto fan operation
    p. Refrigerant Refrigerant Leak detection logic

6. Unit shall be capable of refrigerant piping in four different directions.
7. Unit shall be capable of drain piping in two different directions.

D. Fan Assembly

1. The unit shall have a single, direct driven crossflow tangential Sirocco fan made of high strength ABS BSN-7530 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
4. The fan motor shall include thermal, overcurrent and low RPM protection.
5. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
6. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of three pre-programed fan speeds in the heating mode and fan only mode and four speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.
7. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.
8. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
9. Unit shall have factory installed motorized louver to provide flow of air in up and down direction for uniform airflow.
10. Unit shall have factory installed motorized guide vane to control the direction of flow of air from side to side.

E. Filter Assembly

1. The return air inlet shall have a factory supplied removable, washable filter
2. The filter access shall be from the front of the unit without the need of tools.

F. Coil Assembly

1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.
3. Unit shall have a minimum two row coil, 18 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).
5. Unit shall be designed for gravity drain.
6. Unit shall have a 5/8" inside diameter factory insulated drain hose to handle condensate.
7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 550 psig.
9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately.
10. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.

G. Microprocessor Control

1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted zone controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode.
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core stranded, twisted, and shielded communication cable (RS-485).
3. The unit controls shall operate the indoor unit using one of the five operating modes:

    a. Auto changeover (Heat Recovery System only)
    b. Heating
    c. Cooling
    d. Dry
    e. Fan only

4. The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.
5. The unit shall be able to operate with the fan turned off during system cooling thermal off.
6. The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.
7. The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.
8. Unit shall have a field settable method to choose auto fan speed change operation based on mode of operation, on/off fan operation based on mode of operation, or continuous minimum set fan speed operation.

H. Electrical

1. The unit electrical power shall be 208-230/1/60 (V/Ph./Hz).
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS485 daisy chain.

2.9 LG CEILING CASSETTE – 1 WAY

A. General

1. Unit shall be manufactured by LG.
2. Unit shall be designed for indoor application.
3. Unit shall be designed to mount recessed in the ceiling and has a surface mounted grille with air inlet and outlet.

B. Casing/Panel

1. Unit case shall be manufactured using galvanized steel plate.
2. The unit shall be provided with an off-white Acrylonitrile Butadiene Styrene (ABS) polymeric resin grille.
3. The grille shall have a tapered trim edge, and a hinged, spring clip (screw-less) return air filter-grille door.
4. Unit shall be provided with metal ears designed to support the unit weight on four corners.
5. Ears shall have pre-punched holes designed to accept field supplied all thread rod hangers.

C. Cabinet Assembly

1. Unit shall have one supply air outlet and one return air inlet.
2. The supply air outlet shall be through a single directional slot diffuser with oscillating motorized guide vane designed to change the airflow direction.
3. The grille shall have a discharge range of motion of 40° in an up/down direction with capabilities of locking the vanes.
4. Unit shall have factory installed motorized louver to provide flow of air in up and down direction for uniform airflow.
5. Unit shall be equipped with factory installed temperature thermistors for:

    a. Return air
    b. Refrigerant entering coil
    c. Refrigerant leaving coil

6. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
7. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit main processor.
8. The unit shall have provision of fresh air ventilation through a knock-out on the cabinet.
9. Unit shall have the following functions as standard:

    a. Self-diagnostic function
    b. Auto addressing
    c. Auto restart function
    d. Auto changeover function (Heat Recovery system only)
    e. Auto operation function
    f. Child lock function
    g. Forced operation
    h. Dual thermistor control
    i. Sleep mode
    j. Dual set point control
    k. Filter life timer
    l. External on/off input
    m. Wi-Fi compatible
    n. Auto fan operation
    o. Refrigerant Leak detection logic

D. Fan Assembly

1. The unit shall have a single, direct driven, crossflow tangential Sirocco fan made of high strength ABS GP-2305 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
4. Fan speed shall be controlled using microprocessor based digitally controlled algorithm that provides a minimum of four pre-programed fan speeds in the heating mode and fan only mode and five speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.
5. The fan motor shall include thermal overload and low RPM protection.
6. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, super high, Power Cool, and Auto. The fan motor shall include thermal overload and low RPM protection.
7. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, super high, Power Cool, and Auto.
8. In heating mode, the indoor fan shall have the following settings: Low, Med, High, super high and Auto.

E. Filter Assembly

1. The return air inlet shall have a factory supplied removable, washable filter
2. The filter access shall be from the bottom of the unit without the need for tools.

F. Coil Assembly

1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.
3. Unit shall have a minimum two row coil, 21 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).
5. Unit shall include an installed and wired condensate drain lift pump capable of providing minimum 27.5 inch lift from bottom surface of the unit.
6. Unit shall have a 1.0” ID factory insulated drain hose to handle condensate.
7. The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan.
8. Unit shall have provision of 45° flare refrigerant pipe connections.
9. The coil shall be factory pressure tested at a minimum of 550 psig.
10. All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.

G. Microprocessor Control

1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core, stranded, twisted, and shielded communication cable (RS485).
3. The unit controls shall operate the indoor unit using one of the five operating modes:
4. Auto changeover (Heat Recovery System only)
    a. Heating
    b. Cooling
    c. Dry
    d. Fan only

5. The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.
6. The unit shall be able to operate with the fan turned off during system cooling thermal off.
7. The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.
8. The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.
9. Unit shall have a field settable method to choose auto fan speed change operation based on mode of operation, on/off fan operation based on mode of operation, or continuous minimum set fan speed operation

H. Electrical

1. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS-485 daisy chain.

2.10 LG CEILING CASSETTE – 4 WAY

A. General

1. Unit shall be manufactured by LG.
2. Unit shall be designed to be installed for indoor application.
3. Unit shall be designed to mount recessed in the ceiling and has a surface mounted grille on the bottom of the unit.
4. The unit shall be available in both nominal 2’ x 2’ and 3’ x 3’ chassis.

B. Casing/Panel

1. Unit case shall be manufactured using galvanized steel plate.
2. The unit panel shall be provided with an off-white or black Acrylonitrile Butadiene Styrene (ABS) polymeric resin grille.
3. The grille shall have a tapered trim edge, and a hinged, spring clip (screw-less) return air filter-grille door.
4. Unit shall be provided with metal ears designed to support the unit weight on four corners.
5. Ears shall have pre-punched holes designed to accept field supplied all thread rod hangers.
6. Unit shall be supplied with snap off access panels to facilitate leveling of unit without removing the grille.

C. Cabinet Assembly

1. Unit shall have four supply air outlets and one return air inlet.
2. The supply air outlet shall be through four directional slot diffusers each equipped with independent oscillating motorized guide vanes designed to change the airflow direction.
3. The grille shall have a discharge range of motion of 40° in an up/down direction with capabilities of locking the vanes.
4. The unit shall have a guide vane algorithm designed to sequentially change the predominant discharge airflow direction in counterclockwise pattern.
5. Guide vanes shall provide airflow in all directions.
6. Unit shall be equipped with factory installed temperature thermistors for:

    a. Return air
    b. Refrigerant entering coil
    c. Refrigerant leaving coil

7. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
8. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.
9. The unit shall have factory designated branch duct knockouts on the unit case.
10. The unit shall have provision of fresh air ventilation through a knock-out on the cabinet.
11. The branch duct knockouts shall have the ability to duct up to 1/2 the unit airflow capacity.
12. The branch duct cannot be ducted to another room.
13. Unit shall have the following functions as standard:
    a. Self-diagnostic function
    b. Auto addressing
    c. Auto restart function
    d. Auto changeover function (Heat Recovery system only)
    e. Auto operation function
    f. Child lock function
    g. Forced operation
    h. Dual thermistor control
    i. Sleep mode
    j. Dual set point control
    k. Multiple aux heater applications
    l. Filter life timer
    m. External on/off input
    n. Wi-Fi compatible
    o. Auto fan operation
    p. Leak detection logic

D. Fan Assembly

1. The unit shall have a single, direct-drive turbo fan made of high strength ABS HT-700 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
4. The fan motor shall include thermal, overcurrent and low RPM protection.
5. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
6. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of four pre-programed fan speeds in the heating mode and fan only mode and five speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.
7. A field setting shall be provided to vary air throw pattern to compensate for high ceiling installations.
8. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Super high, Power Cool, and Auto.
9. In heating mode, the indoor fan shall have the following settings: Low, Med, High, Super high and Auto.
10. Unit shall have factory installed motorized louver to provide flow of air in up and down direction for uniform airflow.

E. Filter Assembly

1. The return air inlet shall have a factory supplied removable, washable filter.
2. The filter access shall be from the bottom of the unit without the need for tools.
3. The nominal 3'x3' cabinet unit shall have provision for an optional auto-elevating grille kit designed to provide motorized ascent/descent of the return air grille/pre filter assembly.

    a. The ascent/descent of the return air grille shall be up to a distance of 14-3/4 feet allowing access to remove and clean the filter.
    b. The auto-elevating grille shall have a control algorithm to accept up, down and stop control commands from the controller.
    c. The auto-elevating grille shall have a control to stop the descent automatically if a contact is made with any obstacle.

F. Coil Assembly

1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.
3. Unit shall have a minimum one or two row coil, 18-19 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).
5. Unit shall include an installed and wired condensate drain lift pump capable of providing minimum 27.5 inch lift from bottom surface of the unit.
6. The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan.
7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 550 psig.
9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.

G. Microprocessor Control

1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system.
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core, stranded, twisted and shielded communication cable.
3. The unit controls shall operate the indoor unit using one of the five operating modes:

    a. Auto changeover (Heat Recovery System only)
    b. Heating
    c. Cooling
    d. Dry
    e. Fan only

4. The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.
5. The unit shall be able to operate with the fan turned off during system cooling thermal off.
6. The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.
7. The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.
8. Unit shall have a field settable method to choose auto fan speed change operation based on mode of operation, on/off fan operation based on mode of operation, or continuous minimum set fan speed operation.

H. Electrical

1. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS-485 daisy chain.

2.11 LG FLOOR STANDING – CASED AND UNCASED

A. General

1. Unit shall be manufactured by LG.
2. Unit shall be factory assembled, wired, piped and run tested.
3. Unit shall be designed to be installed for indoor application.
4. The unit shall be designed to be free standing on the floor against a wall with factory supplied enclosure or may be located within a field provided architectural enclosure
5. The back plate of the unit shall have two side mounting flanges with bolt holes to allow a secure attachment of the unit to a vertical surface at or above the floor
6. The discharge shall be vertical from the top of the unit.
7. The return air shall be from the bottom front through a toe slot at floor level.
8. The discharge air opening shall be covered with an architectural grille for units supplied with factory enclosure
9. Floor standing indoor units without enclosure shall be installed under a field supplied and installed enclosure that does not introduce any significant external static pressure.

B. Casing/Panel

1. The units supplied with factory enclosure shall be manufactured using coated metal frame covered with an off white ABS architectural polymeric resin exterior case.
2. The cold surface shall be covered with a coated polystyrene insulating material.
3. The unit shall have a flip open controller access door that shall cover the control mounting bays located on both ends of the top panel.
4. The unit shall have a polymeric resin coated metal safety grille provided behind the removable filters.

C. Cabinet Assembly

1. Unit shall have one supply air outlet and one return air inlet at the toe slot at the floor level.
2. Unit shall be equipped with factory installed temperature thermistors for:
    a. Return air
    b. Refrigerant entering coil
    c. Refrigerant leaving coil
3. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
4. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit main processor.
5. Unit shall have the following functions as standard:
    a. Self-diagnostic function
    b. Auto addressing
    c. Auto restart function
    d. Auto changeover function (Heat Recovery system only)
    e. Auto operation function
    f. Child lock function
    g. Forced operation
    h. Dual thermistor control
    i. Sleep mode
    j. Dual set point control
    k. Multiple aux heater applications
    l. Filter life timer
    m. Power consumption data
    n. External on/off control input
    o. Wi-Fi compatible
    p. Auto fan operation
    q. Refrigerant Leak detection logic

D. Fan Assembly (7-15 MBH):

1. The unit shall have three direct driven Sirocco fans made of high strength ABS HT-700 polymeric resin.
2. The fans shall be mounted on common shaft.
3. The fan impeller shall be statically and dynamically balanced.
4. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
5. The fan motor shall include thermal, overcurrent and low RPM protection.
6. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
7. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of three pre-programed fan speeds in the heating mode and fan only mode and four speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.
8. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
9. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
10. Unit shall be designed for high speed air volume against an external static pressure of up to 0.08” water gauge (uncased).

E. Fan Assembly (18-24 MBH):

1. The unit shall have two independent fan assemblies consisting of two motors and four direct driven Sirocco fans made of high strength ABS HT-700 polymeric resin.
2. The fans shall be mounted on common shaft.
3. The fan impeller shall be statically and dynamically balanced.
4. The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.
5. The fan motor shall include thermal, overcurrent and low RPM protection.
6. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
7. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm. That provides a minimum of three pre-programed fan speeds in the heating mode and fan only mode and four speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.
8. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.
9. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
10. Unit shall be designed for high speed air volume against an external static pressure of up to 0.24” water gauge (uncased).

F. Filter Assembly

1. The return air inlet shall have two factory supplied primary removable, washable filters on the 7-15MBh models.
2. The return air inlet shall have three factory supplied primary removable, washable filters on the 18-24MBh models.
3. The unit shall have an access to the filter media through toe slot located on the front of unit without the need to remove any panels.
4. The filters shall be accessible without removing the unit panel.

G. Coil Assembly

1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.
3. Unit shall have minimum of a two row coil, 19 fins per inch.
4. Unit shall be designed for gravity drain.
5. Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).

6. Unit shall have a factory insulated drain hose to handle condensate.
7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 550 psig.
9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.

H. Microprocessor Control

1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core, stranded, twisted and shielded communication cable.
3. The unit controls shall operate the indoor unit using one of the five operating modes:
   a. Auto changeover (Heat Recovery System only)
   b. Heating
   c. Cooling
   d. Dry
   e. Fan only
4. The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.
5. The unit shall be able to operate with the fan turned off during system cooling thermal off.
6. The unit shall be able to operate with a continuous fan setting.
7. The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.
8. The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.

I. Electrical

1. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

J. Controls

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS-485 daisy chain.
2. Seismic Installations

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install unit on vibration isolators. Reference Section 23 05 48.

C. Locate indoor and outdoor units as indicated on drawings. Provide service clearance per manufacturer’s installation manual. Adjust and level outdoor units on support structure.

D. Components / Piping:

1. Installing contractor shall provide and install all accessories and piping for a fully operational system. Refer to manufacturer's installation manual for full instructions.
2. Traps, filter driers, and sight glasses are NOT to be installed on the refrigerant piping or condensate lines.
3. Standard ACR fittings rated for use with R410A are to be used for all connections. Proprietary manufacturer-specific appurtenances are not allowed.

E. Insulation:

1. Refrigerant lines, as well as any valves, shall be insulated end to end. See 23 07 00 specifications.

END OF SECTION

SECTION 23 82 16

AIR COILS

PART 1 - GENERAL

1.1 SAFETY STANDARDS

A. Provide electric heating coil in compliance with the National Electric Code and listed by UL for zero clearance and so labeled.

1.2 CAPACITY RATINGS

A. Hydronic Coils: Certified per ARI 410.

1.3 SUBMITTALS

A. Submit manufacturer's product data including:

1. Performance data.
2. Accessories description
3. Operating weight.
4. Drawings showing:
   a. Dimensions.
   b. Sizes and locations of connections.
5. Support requirement.

1.4 FACE VELOCITY

Unless otherwise noted face velocities shall not exceed the following:

A. Cooling Coils: 475 fpm.

B. Heating Coils: 700 fpm. (except electric coils)

PART 2 - PRODUCTS

2.1 ELECTRIC HEATING COILS (FINNED TUBULAR HEATER)

A. Manufacturers:

1. Design Basis: Indeeco
   a. Model: Type TFZU Custom Flanged Heater
2. Other Acceptable Manufacturers:
   a. Brasch.
   b. Trane.
   c. Warren

B. Heating elements shall consist of coil, 80% nickel, 20% chromium, Grade A resistance wire precisely centered in a 304 stainless steel tube filled with granular magnesium oxide. A stainless-steel fin is to be helically wound onto the tube. Elements are to be furnished with mounting flanges, making them individually removable through the terminal box.

C. Heater frames and terminal boxes shall be corrosion resistant steel. Unless otherwise indicated, the terminal box shall be NEMA 1 construction and shall be provided with a hinged latching cover and multiple concentric knockouts for field wiring.

D. All heaters shall be furnished with triple overtemperature protection. A disc type and linear, automatic reset thermal cutout are included for primary overtemperature protection. All heaters must also be furnished with a linear type manual reset thermal cutout with backup contactors (as required). For secondary overtemperature protection, heat limiters or other fusible overtemperature devices are not acceptable.

E. Heaters shall be rated for the voltage, phase and number of heating stages indicated in the schedule. All 3-phase heaters shall have equal balanced 3-phase stages. All internal wiring shall be stranded copper with 105°C insulation and shall be terminated in crimped connectors or box lugs.

F. Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75°C copper wire rated in accordance with NEC requirements.

G. Heaters shall be furnished either with the Control Option specified in the schedule and described below or with the specific components listed in the schedule.

1. Thermal cutouts, airflow switch, contactors (where required), SCR (with step controller if heater draws over 96 amps 3-phase or 192 amps single phase), fuses (if over 48 amps), control circuit transformer (where required) and built-in, snap-acting, door interlocked disconnect switch.

H. Description:

1. Heaters shall be U.L. listed for zero clearance and meet all the applicable requirements of the Latest Edition of National Electrical Code or other local codes.

2. Heaters shall be made with galvanized or aluminum steel frame.

3. The terminal box shall be provided with solid hinged cover in order to minimize dust infiltration.

4. Heaters shall be suitable for mounting in a horizontal or vertical duct, as shown on the Drawings, and air flow may be through the heater in either direction.

5. Overcurrent protection shall consist of built-in and pre-wired dual element fuses with clip reinforcing springs.
   a. With one overcurrent device for each 40 ampere circuit.
   b. And with one overcurrent device for entire heater for those heaters rated 40 amperes or less only.

6. A disc type automatic reset thermal cutout in control lines, shall be furnished for primary protection. Heat limiters in all power lines shall be provided for secondary protection. In addition a disc type manual reset thermal cutout with bulb extending the length of the heater shall be furnished. Manual reset thermal cutout to be in series with automatic reset thermal cutout. All three devices shall be serviceable through the terminal box, without having to remove heater from duct. In lieu of heat limiters, disc type manual reset thermal cut-outs will be acceptable.

7. Air ducts rated as Class 1 in accordance with UL 181, air duct coverings and linings shall be interrupted at the immediate area of operation of such heat sources in order to meet the clearances specified by the manufacturer.

8. The following accessories shall be furnished and built in for each heater, unless otherwise noted:
   a. Insulated terminal box.
   b. Magnetic contactors (when load exceeds control device ratings).

c. Transformer with primary fuse protection to supply control voltage, when power supply exceeds 120 volts.
d. Air flow switch - pressure type.
e. Control contact for each step.
f. Non-fused disconnect with interlocking door handle.

9. Controls:
   a. Provide factory mounted and wired control panel.
   b. Control Option: SCR
   c. Thermostat: Room
   d. Standard Features:
      1) Thermal Cutoffs.
      2) Airflow Switch.
      3) Magnetic Contactors.
      4) Control Transformer.
      5) Fuses.

2.2 REFRIGERATION COILS

A. Tubes - Round, seamless copper tubes, arranged in parallel pattern with respect to airflow.

B. Fins - Plate-Tube, Sigma-Flo II configurated, aluminmum fins producing identical capacities. Fins continuous across entire coil width and die-formed in multiple stages for accurate tube fit, fin bonding and spacing. Fins mechanically bonded to tubes for lasting reliability.

C. Casing - Continuous coated galvanized steel, 16 gauge formed end supports and top and bottom channels. 3/8" holes on 3" centers in channels for mounting or fastening coils together. One 16 gauge continuous coated, galvanized steel center tube support on ordering lengths over 42". Two or more supports on lengths over 96".

D. Test and Working Pressure - Proof tested at 450 psig and leak tested at 300 psig air pressure under water, cleaned, dehydrated and sealed with dry nitrogen charge. Suitable for working pressures up to 250 psig.

E. U-Bends - Round, seamless copper tubes, 5/8" O.D., machine die-formed on each end to provide accurate fit for silver brazed joints.

F. Distributor - Equalizing type refrigerant distributors of low pressure drop design, arranged for down feed. Male sweet connections. Maximum of twelve circuits per single distributor. Split evaporator.

G. Air Bypass and Water Carryover Arrestor - Foam sealing strip located between casing channels and fins along top and bottom.

H. Designed to conform to ANSI-B9.1 Safety Code for mechanical refrigeration.

I. Coils to be vertical split.

J. Accessories:

1. Distributor with hot gas bypass connection.
   a. Thermal expansion valve.
   b. Size per manufacturers requirements.
   c. Insulate sensing bulb.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install coils level and plumb.

B. Provide necessary auxiliary support.

C. Adjust air flow switch for safe operation.

D. When electric heating coils are used and the airflow sensor is a pressure sensor type, provide adjustable volume damper(s) as necessary downstream of VAV box before first split in ductwork in order to create sufficient total pressure at the air flow pressure sensor to properly verify air flow.

E. Check and adjust all controls.

F. Pipe condensate drain from cooling coils as shown on the drawings or to nearest floor drain or mop sink.

G. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

H. Install coils where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that coils comply with requirements and serve intended purposes.

I. Coordinate with other work as necessary to interface installation of coils with other components of systems.

END OF SECTION

SECTION 23 82 39

HEATING TERMINAL UNITS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data:

1. Performance data.
2. Drawings.
   a. Dimensions
   b. Support requirements
   c. Size and location of connections
3. Enclosure gauges.
4. Accessories.
5. Parts lists.
6. Additional Submittal Requirements for Fan Coil Units, Cabinet Heaters and Unit Heaters:
   a. Wiring diagrams.
   b. Installation, operating and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products as indicated by published product information, and as required for a complete installation.

2.2 CABINET UNIT HEATERS

A. Manufacturers:

1. Design Basis: Trane.
2. Other Acceptable Manufacturers:
   a. Carrier
   b. Modine
   c. McQuay
   d. Mark Hot
   e. Sterling
   f. Vulcan

B. Construction:

1. Coils:
   a. Fins: Aluminum.
   b. Tubes: Copper.
   c. Working Pressure: 250 psig.
2. Casing:
   a. Material: 16 gauge steel.
   b. Corners: Rounded, 1" minimum radius.
   c. Finish: Phosphatized and painted inside and out with one coat of baked-on enamel.

d. Color: Selected by Architect/Engineer from manufacturer's standard colors.
e. Heating Element Supports: Adjustable.
f. Gaskets: Between front panel and enclosure.

3. Grilles: Fabricated steel bar grille.
   a. Directional Louvers: Under grille.
4. Fans:
   a. Arrangement: Blow-through
   b. Type: Multi-wheel, DWDI, FC, aluminum.
   c. Balance: Factory balance, static and dynamic.
   d. Drive: Direct.
5. Motors:
   a. Type: brushless DC (BLDC)/electronically commutated motors (ECM)
   b. Insulation: Class B.
   c. Protection: Built-in thermal overload.
6. Filters: Disposable, ¾" or 1" thick.
7. Filters: Permanent.
   a. Type: Permanent.
   b. Material: Metal.
   c. Thickness: 1"

C. Basic unit shall include chassis, coil, fanboard, fanwheel(s), housing(s), motor and insulation. Chassis is galvanized steel wrap-around structural frame with all edges flanged. Insulation is faced, heavy density glass fiber.

D. Vertical Cabinet Models

1. 16 gauge steel front panels and 18 gauge steel end and top panels have channel-formed edges around entire panel perimeters. Front panel insulated over entire coil section. Integral, stamped outlet grilles have 15˚ deflection from vertical. Stamped lattice discharge grilles on inverted airflow models. Access door on coil connection side of unit. Front panel removable without tools.

E. Vertical Recessed Models

1. 16 gauge steel, four-side overlap front panels, with "M"-shaped stiffener running entire panel length as standard. Integral, stamped inlet and outlet grills have 15º downward deflection. Front panel insulated over entire coil section. Front camlocked access doors on righthand side of unit. Front panel removed with two screws.

F. Horizontal Cabinet Models

1. 18 gauge steel panels. Bottom and end panels have channel-formed edges around entire panel perimeter. Integral, stamped outlet grilles have 15˚ downward deflection. Stamped lattice inlet grilles. Bottom panel hinged at front and camlocked at back.

G. Horizontal Recessed Models

1. 18 gauge steel, removable, four-side overlap bottom panel adjustable 3/8" with full length, piano-type hinge at back and camlocks at front.

H. Electric Heat Coils

1. The auxiliary electric heating coil is provided as either the total source of heat or auxiliary intermediate season heating. The electric heat coils are located in the preheat position, and are the open-wire type. The coils are a nickel chromium element design. The electric heat operates at the same voltage as the unit, and only a single power connection is necessary. All units with factory-mounted electric heat are UL-listed and interlocked with the fan motor switch. A call for electric heat operation will turn the fan on. Motors controls are synchronized with fan/valve operation to ensure safe operation and to ensure that two modes of heat are not operating simultaneously. A transformer is supplied on any voltage unit, eliminating the need for field installation of a step-down transformer. Unit-mounted quiet magnetic relays are supplied on all voltages. A high temperature cutout with automatic reset is provided as an integral part of the elements to de-energize the electric heat in the event of a malfunction.

I. Fans

1. Fan wheels centrifugal, forward-curved, double of non-corrosive, molded, fiberglass-reinforced thermo-plastic material on all units except electric heat and inverted airflow models which use aluminum. Fan housings of formed sheet metal on 200-600 cfm units. 800-1800 cfm units have end caps made of non-corrosive, molded, fiberglass-reinforced thermo-plastic material, and fan scrolls of galvanized steel.

J. Motors

1. All motors are brushless DC (BLDC)/electronically commutated motors (ECM) factory-programmed and run-tested in assembled units. The motor controller is -mounted in a touch-safe control box with a built-in integrated user interface and LED tachometer. If adjustments are needed, motor parameters can be adjusted through momentary contact switches accessible without factory service personnel on the motor control board.

2. Motors will soft-ramp between speeds to lessen the acoustics due to sudden speed changes. Motors can be operated at three speeds or with a field-supplied variable speed controller. The motor will choose the highest speed if there are simultaneous/conflicting speed requests.

3. All motors have integral thermal overload protection with a maximum ambient operating temperature of 104°F and are permanently lubricated. Motors are capable of starting at 50 percent of rated voltage and operating at 90 percent of rated voltage on all speed settings. Motors can operate up to 10 percent over voltage.

K. Controls Interface

1. The control interface is intended to be used with a field-supplied, low-voltage thermostat or controller. The control box contains a relay board which includes a line voltage to 24-volt transformer, quiet contactors (for electric heat units), and an optional disconnect switch. All end devices are wired to a low-voltage terminal block and are run-tested, so the only a power connection and thermostat connection is needed to commission the unit. Changeover sensors and controls are provided whenever a change-over coil is selected. When NO valves are selected, inverting relays are provided for use with standard thermostats.

L. Fan Speed Control

1. The fan speed control is available with or without the control interface option and is available as wall-mount or unit-mount. The speed control incorporates a 0-10 VDC signal providing limitless control of the motor RPM between the factory set low and high speeds. The control box contains a line voltage to 24-volt transformer, ECM motor controller, and an optional disconnect switch.

M. Filters

1. Filters are concealed from sight and easily removable. Filters are located behind an integral access door on horizontal type units. Filters are either 1" throwaway, MERV 8.

2. Units equipped with 1" MERV 8 filters have a rating based on ASHRAE Standard 52.2. The average dust spot efficiency is no less than 35 to 40 percent when tested in accordance with ASHRAE 52.1 atmospheric dust spot method.

N. Tamperproof Locks

1. Key-operated locking access doors and/or panels will help prevent nuisance tampering with unit and/or controls. Tamperproof locks are available on vertical cabinet, horizontal cabinet, vertical wall-hung cabinet, vertical recessed, and vertical slope-top units.

O. False Backs

1. False backs increase the depth of a vertical cabinet unit and provide a cavity through which to run piping behind the unit. False backs are also an excellent application when installing a unit beneath a window sill that extends out past the front of the unit.

2. False backs are 18-gauge steel construction and have the same paint finish as the unit. The false back is available in depths between 2"– 8" in 1" increments, with height and width identical to the unit's dimensions.

P. Quad Grille Outlet

1. Quad grilles are square multi-directional grilles that allow four different discharge directions by rotating the grilles 90°. The quad grille is constructed of a black plastic material (NORYL-SE 1-731) with a 15° angle on the discharge louvers. Quad grilles are available on all cabinet style units.

Q. Electrical Performance

1. All units shall be wired in accordance with National Electric Code. Underwriters Laboratories, Inc. listed. Provide a junction for motor cord.

R. Unit color subject to architect's approval.

2.3 ELECTRIC UNIT HEATERS

A. Manufacturers:

1. Design Basis: Trane.
2. Other Acceptable Manufacturers:
   a. Modine
   b. Carrier
   c. McQuay

d. Dunham-Bush

B. Construction:

1. Casing:
   a. Material: Steel.
   b. Finish: Baked-on enamel.
   c. Heating Element Supports: Adjustable.
   d. Gaskets: Between front panel and enclosure.

2. Grilles: Louver: Adjustable.
3. Heating Element: Finned steel sheaths providing extended surface.
4. Provide manufacturer's written certification that unit is suitable for use at altitude of the project.

C. Control box housing, all heater wiring controls and contractors shall be located at bottom of heater and equipped with swing down hinged cover. Wiring diagram shall be attached to the inside of the control box cover.

D. 3-Pole units shall have a built in heavy duty 3-pole contactor.

E. Heating element shall be of non-flowing design consisting of special resistance wire enclosed in a steel sheath to which steelplate fins are brazed. Heating element shall cover the entire air discharge area for uniform heating.

F. Thermal safety cutout shall be built into system to automatically shut off heater in event of overheating.

G. Electric space thermostat shall be furnished by the unit manufacturer for installation by automatic controls contractor.

H. Disconnect switch shall be provided under Electrical Documents.

2.4 ELECTRIC BASEBOARD

A. Manufacturers:

1. Design Basis: Vulcan
2. Model: SBT-PD
3. Other Acceptable Manufacturers:
   a. Indeeco
   b. Sterling

B. The front cover shall be 12 gauge extruded aluminum construction suitable for Architectural, Commercial and Industrial use with 1/4" pencil proof intake and discharge grills.

C. The cover shall be linear mount to the 12 gauge heater back with no visible fasteners. The 12 gauge heater back shall be suitable for mullion to mullion mounting.

D. Shall have 2" adjustable pedestals and the heater back will be painted to match the front cover. Standard painted finishes or clear anodizing shall be provided as specified by the architect. Color shall match architects specifications, coordinate with architect prior to ordering.

E. All heaters shall contain 3/4" EMT built in raceway with factory wiring to provide field wiring from either end.

F. 1/2" and 3/4" knockouts shall be provided in the side and rear of the heater junction box to permit end to end wiring. All blank sections shall be fully enclosed to allow branch circuit wiring. All heaters shall contain a full length thermal overheat protector with automatic reset. Wattages shall be available from 100 to 500 watts per foot. Heating

elements shall be tubular stainless steel or aluminum tubing with aluminum fins mechanically bonded to ensure efficient heat transfer.

G. Element fin temperature shall not exceed 350 degrees Fahrenheit to ensure long element life. Elements shall be center anchored and free floating in nylon bushings at each end.

H. Control sections include 6" or 12" with: disconnect, thermostat, pneumatic relay, transformer relay, relay, fused disconnect or duplex receptacle. Standard built-in controls shall include thermostats (single and double pole) and disconnect switches.

I. Built-in controls shall be tamper proof and shall be adjustable with a blade screwdriver through the discharge louver.

J. Provide all corners, fillers, blank section, and end caps as required for indicated installation.

K. All heaters are Underwriters Laboratories listed.

2.5 ELECTRIC TRENCH HEATER

A. Manufacturers:

1. Design Basis: Kampmann
2. Model: Katherm QE

B. Construction and Accessories:

1. Heavy gauge galvanized sheet metal trench casing
2. Aluminum roll-up grille by factory for field installation
3. Tangential fan with EC motor
4. Stainless steel heating elements with aluminum-zinc fins
5. High-limit thermal protection with auto reset
6. Height adjustable feet with acoustic decoupling

2.6 AIR CURTAIN FOR LOADING DOCK AREA

A. Air curtain to be furnished as complete factory assembled units consisting of casing, split housing fan scrolls for easy access, min. 16 ga. centrifugal fans, discharge grille and motor specifically designed to provide a uniform velocity across the entire width of unit. Grease fittings located at outside cabinet. Unit shall have a windstopping capability of 17 MPH when mounted 14 feet above floor level.

B. Unit shall be furnished in single increments, multiple units shall not be permitted, and shall be of sufficient structural strength so that it may be supported from both ends without intermediate support. Unit casings shall be a minimum of 14 gauge steel and finished in a blue epoxy enamel.

C. Motors shall be totally enclosed, air over equipped with heavy duty thrust bearings and double extended shafts requiring no outboard bearings. Primary motor voltage shall be 460 V., 3 phase.

D. Fans shall be forward curved centrifugal type, double inlet, double width design with brazed hubs. Tangential type blowers and coupling connections shall not be permitted.

E. Discharge grille shall be double deflection type with airfoil shaped extruded aluminum vanes.

F. Unit shall have proportional volume control for 50% of maximum volume except for fly control units. Under reduced volume, depth of air stream shall remain identical to full grille depth. Volume control shall be designed to save energy on reduced volume.

G. Air curtain shall be furnished with a door switch to energize the unit whenever the door is opened.

H. Units to be provided with factory fabricated, factory wired remote control panels including motor starters, transformer for low voltage door switch and terminal strip for connection to power source and disconnect switch. Integral coil shall be hot water type with capacities as indicated on the Drawing.

I. Coils shall be constructed of non-ferrous fins mechanically bonded to copper tubes. Suitable means for tube expansion shall be made by tube bends or by provision for the coil to move within the casing. All coils shall have a factory performed 400 psi pressure test.

PART 3 – EXECUTION

3.1 GENERAL

A. Locate units so clearance is provided for:

1. Service and maintenance.
2. Enclosure removal.

B. Level or pitch elements as required:

1. Install shims if necessary.

C. Touch-up finish after final adjustment.

D. Replace damaged enclosures.

E. Straighten bent fins.

F. Replace damaged elements.

END OF SECTION

SECTION 23 90 00

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Test and balance reports
5. Record drawings
6. Permit requirements
7. Valve tag list

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for life safety systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.
4. Test and Balance report.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the mechanical systems.

B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary – Mechanical

- ☐ All required submittals have been submitted and either been approved or modified in accordance with the Engineer's "make corrections noted" comments.
- ☐ Clean filters installed in all units. (Install just prior to building turnover)
- ☐ All equipment has been started up and is functioning within manufacturers' recommendations without any undue noise or vibration. (Submit a list of equipment with startup dates. Provide list at a point 65% into construction schedule).
- ☐ All vibration isolation has been installed and is operating properly.
- ☐ Duct access doors have been installed at fire and fire/smoke dampers and are properly fire-stopped and fire and fire/smoke dampers have been visually inspected to confirm that they are open.
- ☐ Access doors have been installed as required for concealed equipment, water hammer arrestors, valves, controls, actuators, etc.
- ☐ Chemical treatment system installed per specification and functioning properly.
- ☐ All equipment has been installed with the manufacturers recommended service clearances and is fully accessible for required maintenance.
- ☐ All equipment and piping is labeled per specifications.
- ☐ All piping cleaned, flushed and tested per specifications. Submit all required test and balance reports for record.
- ☐ All action items are complete as listed in the action items reports. Submit a list of action items with sign off by Architect or Engineer for record. Punch list to be completed prior to turn over of building.
- ☐ Temperature control system complete and tested per specifications.
- ☐ Test and balance complete and report submitted and accepted by Engineer.
- ☐ Operation and maintenance manuals submitted with table of contents and required documentation for extended warranties.
- ☐ Factory Testing documented and submitted for record.
- ☐ Record drawings submitted per specifications.
- ☐ Temperature Control record documents provided per specifications.
- ☐ Temperature Control Point to point checkout documents submitted.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 COORDINATION WITH OTHERS

A. The Division 21 through 23 contractor shall coordinate his requirements with the General Contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 21 through 23 systems.

3.3 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

DIVISION 26
ELECTRICAL

ELECTRICAL TABLE OF CONTENTS
SPECIFICATIONS
DIVISIONS 26 & 28

END OF ELECTRICAL TABLE OF CONTENTS

SECTION 26 05 01

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. The Divisions 21, 22, 23, 24, 25, 26, 27 and 28 contractor(s) shall comply with the provisions of this section. The Divisions 21, 22, 23 and 25 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26, 27 and 28 contractor(s).

B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21, 22, 23 and 25 System Contractor performing the work, which requires the electrical power.

1. Each Divisions 21, 22, 23 and 25 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26, 27 and 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical), and Division 23 and 25 (control) before submitting any equipment for review or commencing installation.

1.3 DEFINITIONS

A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.

B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.

C. Motor Control Center: A floor mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.

D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.

E. Manual Operation: Operation by hand without the use of any other power.

F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.

G. TC: Temperature Controls = Division 22, 23 or 25 Contractor who furnishes control.

H. EC: Electrical Contractor = Divisions 26, 27or 28 Contractor.

I. FA: Fire Alarm Contractor = Division 25 or 28 Contractor who furnishes Fire Alarm System.

J. SC: Sprinkler Contractor

K. EP: Electric to Pneumatic Converter.

L. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21, 22, 23 and 25 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished By	Set In Place By	Power Wiring By	Control Wiring By
AHU Interior Marine Lights	MC	MC	EC	EC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Motor Speed Controllers: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC, EC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC, EC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC, EC or TC	MC or TC	MC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	MC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	SC	SC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC/FA
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 7)	FA	FA	EC	FA
CO Sensors	TC	TC	TC	TC
Control Air Compressor	TC	TC	TC	TC
Refrigerated Air Dryer	TC	TC	TC	TC
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA/TC (Note 7)
Smoke Control Dampers (for smoke management system) (Note 7)	MC	MC	EC	FA/TC (Note 7)

ITEM -	Furnished By	Set In Place By	Power Wiring By	Control Wiring By
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC (Note 7)

Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC. Electrical Contractor shall provide disconnects for all electrical equipment unless otherwise indicated.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor. Such devices shall be provided at low voltage unless technically impossible
3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided by the electrical contractor.
4. Electrical contractor is responsible for wiring from disconnect to starter and from starter to motor, unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
   a. Electrical Contractor shall provide all power and control wiring to fire/smoke or smoke dampers. HVAC, Controls, Electrical, and Fire Alarm Contractors shall provide parallel control wiring (with fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes, unless otherwise indicated.
   b. Fire alarm system shall override automated building control system during smoke exhaust mode.
   c. TC shall provide additional required wiring and controls when damper also serves a temperature control or zoning function.
7. FA wires to components necessary for the operation and monitoring of the Smoke Management System. TC wires to components utilized in the control and monitoring of the Automated Building Control System. This often requires dual wiring where components are controlled by both. In such case wiring and relays shall be provided to ensure FA takes precedence in control over TC.

B. Power Wiring by Divisions 21, 22, 23 and 25: The electrical power for certain equipment provided under Divisions 21, 22, 23 and 25 may not be specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21, 23 or 25 trade requiring such power.

Sufficient power for this purpose shall be furnished as “spare” dedicated circuit capacity in Division 26’s panelboards. All wiring, conduit and electrical devices downstream of the panelboards is the responsibility of the Divisions 21, 23 and 25 trade requiring the power.

1. Such equipment is hereby defined as:
   a. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing drawings.
   b. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Fire Protection work, and will be shown by that contractor’s engineered system design drawings.
      1) Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under fire alarm work.
      2) Sprinkler Contractor shall provide pre-action control panel and interconnection between nearest suitable fire alarm panel and location of pre-action valve(s).

3) Fire Alarm Contractor shall provide interconnection between fire command center alarm panel and/or remote communication fire alarm panel.

c. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.

d. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in HVAC scope and will be shown by that contractor's control submittal drawings.

e. Motorized dampers and VAV boxes. Required locations and specification are shown on the mechanical drawings and HVAC specifications. HVAC contractor shall provide damper, controls and power.

1.5 GENERAL REQUIREMENTS

A. Connections:

1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

1. Provide magnetic starters for all three phase motors and equipment complete with:
   a. Control transformers.
   b. 120V holding coils.
   c. Integral hand-off-auto switch.
   d. Auxiliary contacts required for system operation plus one (1) spare.
   e. Refer to Motors, Starters and Drives, requirements for additional information.

C. Remote Switches and Pushbutton Stations:

1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. DDC Control Interface:

1. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System prior to submitting bid.

2. All power to controllers and controlled equipment shall be furnished via dedicated line voltage circuits.
3. Dedicated control circuits from electrical panelboards to DDC control panels and from electrical panelboards to dedicated DDC J-boxes (for distributed control components such as VAV boxes), and control transformer line voltage connections shall be provided by HVAC Contractor where required.
   a. Exceptions: Where power wiring has been shown on Electrical Drawings.
4. Low voltage wiring from J-boxes to distributed control components, all low voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23 or 25.
5. Any additional power requirements shall be the responsibility of the Division 23 or Contractor requiring same, and provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste/sanitary, cooling coil drain piping, and roof drain mains and leaders.
2. Plumbing vent piping.
3. Supply, return and exhaust ductwork.
4. Electrical conduit greater than 3" diameter.
5. Hydronic branch and mains (greater than 2", but less than 12").
6. Domestic water mains piping.
7. Fire sprinkler mains and leaders.
8. Hydronic branch piping (2" and less).
9. Domestic water branches.
10. Electrical conduit branch feeders.
11. Fire sprinkler branch piping and sprinkler runouts.

B. Light fixtures have precedence in a zone, extending from the face of the ceiling to an elevation 2" above the height of the light fixtures.

C. Examine the contract documents of all trades (e.g. all Divisions 21, 22, 23, 25, 26 and 28 the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).

D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.

E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.

F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise unaccessible locations.

1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.
2. All system components requiring access shall be grouped together to reduce the quantity of access doors required.

G. See "Basic Mechanical Materials and Methods" for additional access door requirements if section has been included in this specification.

PART 2 – PRODUCTS

2.1 MOTOR HORSEPOWER

A. In general, all motors ½ HP and above shall be three phase, all motors below ½ HP shall be single phase.

B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.

C. Work under Divisions 21, 22 and 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26, 27 and 28, before ordering the equipment.

1. If motor horsepowers are changed under the work of Divisions 21, 22 or 23 without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21, 22 or 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (Not Used)

END OF SECTION

SECTION 26 05 02

ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

B. Where contradictions occur between this Section and Division 1, the most stringent of the two shall apply. Architect shall decide which is most stringent.

C. Provisions of Divisions 21, 22, 23, 27 and 28 shall also apply to the work of this section as if fully repeated here.

D. Provision indicate Section 23 05 01/26 05 01 “Mechanical and Electrical Coordination” shall also apply to the work of this section as if fully repeated here.

1.2 DEFINITIONS

A. The definitions of Division 1 and the General Conditions of this specification also apply to Divisions 26, 27 and 28 Contract.

B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor’s bid or contractor’s negotiations with the Owner. Divisions 26, 27 and 28 drawings and specifications prepared by the Engineer are not construction documents.

C. “Construction Documents”, “construction drawings”, and similar terms for Divisions 26, 27 and 28 Work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s contract documents. These specifications detail the contractor’s responsibility for “Engineering by Contractor” and for preparation of construction documents.

D. “(N)” indicates "new" equipment to be provided under this contract.

E. “(E)” indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.

F. “(R)” indicates existing equipment to be relocated as part of this work.

G. "Furnish" means to "supply" and usually refers to an item of equipment.

H. "Install" means to "set in place, connect and place in full operational order".

I. "Provide" means to "furnish and install".

J. “Equal” or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.

K. "Work by other(s) divisions"; "re:_____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor’s sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Architect/Engineer before submitting bid.

L. By inference, any reference to a “contractor” or “sub-contractor” means the entity, which has contracted with the Owner for the work of the Contract Documents.

M. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

N. “Conduit” includes, in addition to pipe, all fittings, hangers and other accessories related to such conduit.

O. “Concealed” means hidden from sight as in chases, furred spaces shafts, hung ceilings, or embedded in construction.

P. “Exposed” means, “not concealed” as defined above. Work in trenches, crawl spaces, and tunnels shall be considered “concealed” unless otherwise specifically noted.

Q. “Governmental” means all municipal, state and federal governmental agencies.

R. Where any device or part of equipment is herein referred to in the singular number (such as “the conduit”), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.

S. “Electrical Contractor” means the Contractor doing Electrical work.

T. “Security Contractor” means the Contractor doing Security work.

U. “Fire Alarm Contractor” means the Contractor doing Fire Alarm work.

1.3 DESCRIPTION OF WORK

A. The Specifications and the accompanying drawings are intended to secure the provisions of all material, labor, equipment, and services necessary to install complete, tested, and ready for operation the Electrical Systems in accordance with the Specifications and Drawings. The use of the term "provide" shall mean "furnish and install" throughout these specifications and drawings. All systems shall be complete with necessary appurtenances and minor auxiliaries, including pull boxes, offsets to clear interferences, and supports which are not shown but are needed to make each system complete in every respect. All work described in the Specifications and not shown on the Drawings, or vice versa, shall be furnished in complete working order. If mention has been omitted of any item of work or material, necessary for completion of the system, then such items must be and are hereby included. The scope of this project includes, but is not limited to the following work:

1. Raceways and installation components.
2. Wire and Cable.
3. Panelboards.
4. Fuses.
5. Safety and disconnect switches.
6. Distribution equipment.
7. Transformers.
8. Motor controllers.
9. Control equipment.
10. Emergency generators.
11. Transfer switches.
12. Electric service system.
13. Seismic bracing.
14. Utility company coordination and submittals to utility company.
15. Power, control and alarm wiring systems.
16. Grounding system.
17. Lighting fixtures.

18. Dimming system.
19. Site lighting
20. Telephone conduit system.
21. Heating cables and controllers.
22. Lightning protection system.
23. Telecommunications systems.
24. Public address system.
25. Master television cable system
26. Electrical provision for security and building automation system.
27. Door security system.
28. Electrical provisions for fire and life safety.
29. Fire alarm system.
30. Water detection system.
31. Testing.
32. Alternate prices.
33. Furnishing of access doors (see Special Conditions - Article 33).
34. Furnishing and setting of all sleeves through the floors, roof and wall, where required including waterproofing and fireproof sealing and cap flashing.
35. Excavation and backfill (excavation in rock shall be included). All concrete work for pads (including housekeeping pads), bases for outdoor lighting fixtures, and conduit envelopment shall be included.
36. Hardware, such as inserts, bolts, etc., associated with concrete pads.
37. Cutting associated with electrical work.
38. Prime painting, where required for electrical equipment and installation.
39. Removal of existing electrical work in accordance with Architectural Demolition Scheme or as directed and required. Restoration of electrical service in affected adjoining areas which are to continue to function.
40. Provision for temporary light and power.
41. Installation and wiring of starters and controllers.
42. As-built drawings.

1.4 REGULATORY REQUIREMENTS

A. All materials shall conform with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.

B. The latest editions of the following standards are minimum requirements.

1. Underwriters' Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Assoc. (NEMA)
3. American National Standards Institute (ANSI)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. International Electrical Testing Association (NETA)
6. Insulated Cable Engineer's Association (ICEA)

C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:

1. OSHA.
2. National Fire Codes of National Fire Protection Assoc. (NFPA)
3. National Electrical Safety Code (NESC, ANSI C2)
4. National Electrical Code (2014 Edition) with **Poughkeepsie** city, county and state Amendments.
5. **International Building Code 2015 Edition with city, county and state Amendments.**
6. Americans With Disabilities Act (ADA).
7. All applicable Federal, state and local laws, code amendments and regulations.

D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.

E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.

F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

1.5 CONTRACT DOCUMENTS

A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.

B. Light and power and system riser diagrams and schematic diagrams generally indicate equipment connections to be used for various systems. System conduit and wiring shall be as required for actual systems installed on this project. Provide all work shown on diagrams whether or not it is duplicated on the plans.

C. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

D. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

1.6 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 “Submittals” to a scale of ¼” = 1’-0” or larger; detailing major elements, components, and systems of electrical equipment (i.e., all transformer vaults, switchgear rooms, generator rooms, electrical rooms and telephone rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, and materials. Include the following:
   a. Exterior wall and foundation penetrations.
   b. Fire-rated wall and floor penetrations.
   c. Support details.
   d. Sizes and location of required concrete pads and bases.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.
4. Electrical and Transformer Vault Rooms indicating conduit stub-up locations.
5. Cable tray floor plans and elevations showing exact routing.
6. Medium voltage, normal and emergency underground conduit and duct bank routing.

7. Telephone underground conduit and duct bank routing.

1.7 RECORD DRAWINGS

A. Refer to Division 1 for additional requirements.

B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times.

C. Upon completion of the contract and before final payment is authorized, the contractor shall deliver the Owner a set of computerized “as builts” capable of interfacing with AutoCAD software. Drawings shall have to show to scale, where applicable, all work including equipment, controls, etc., as actually installed.

D. Prepare record documents in accordance with the requirements in Division 1 Section “Project Closeout.” In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior and locations of handholes and conduit stub-up locations.
2. Panelboard circuit directories reflecting all field changes.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Results of all testing performed as specified in the specification.
5. Certification of inspection from authorities having jurisdiction.

E. Record the locations and invert elevations of underground installations.

1.8 OPERATING AND MAINTENANCE MANUALS

A. Refer to Division 1 for additional requirements.

B. Submission:

1. O&M manuals submitted for review shall be submitted as PDF documents, one document per manual.
2. For final submission to owner, O&M Manuals shall be submitted as hard copies and digital PDF copies.
3. Bind each hard copy Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings. Mark the back spine of each binder with system identification and volume number.

C. Requirement Contents:

1. Manuals shall have index with tab dividers for each submittal section identifying all equipment and materials installed on the project including a local supplier for replacing a specific piece of equipment.
2. Introduction - Explanation of manual and its use.
3. Description of system or equipment.
    a. Complete schematic drawings of all systems.
    b. Functional and sequential description of all systems.
4. Systems operations:
    a. Operation procedures.
    b. All posted instruction charts.
5. Maintenance
    a. Systems trouble-shooting charts
    b. Procedures for checking out functions.
    c. Recommended list of spare parts.
6. Listing of Manufacturers

7. Manufacturer's Data (where multiple model, type and size listings are included, clearly and conspicuously indicate those that are pertinent to this installation.
   a. Description - literature, drawings, illustrations, certified performance charts, technical data, etc.
   b. Operation
   c. Maintenance - including complete trouble-shooting charts
   d. Parts list
   e. Names, addresses and telephone numbers of recommended repair and service companies.
   f. Guarantee data.
8. Provide certificates for such items of equipment which have warranties in excess of one year.
9. Provide test results for each specification section identified herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Protection of Equipment:

1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor's expense or shall be replaced at the contractor's expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.
4. All electrical enclosures exposed to construction damage such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

C. Owner-furnished equipment and general contractor furnished equipment (such as electrified furniture) shall be delivered, crated or otherwise packaged to the Site delivery point selected by the Construction Manager. This Contractor shall accept delivery of all Owner-furnished and general contractor furnished items which are under his trade jurisdiction and place them in their final location.

D. Where items cannot be immediately placed in their final position, this Contractor shall store and protect all Owner-furnished items until the time of their final installation. He shall be responsible for the care and protection of the items until acceptance by the Owner. Delivery of Utility Company furnished equipment shall be coordinated with the delivery policy of that company

1.10 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to

normal working hours. See also General Conditions.

B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.11 WARRANTIES

A. The warranty period is generally one year after Date of Acceptance.

1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual. Such equipment shall include:

    a. Emergency generator system including transfer switches and transformers
    b. Major electrical switchboard
    c. Lighting fixtures
    d. Lightning protection
    e. Fire alarm system
3. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

1.12 LIABILITY

A. The Contractor shall assume full responsibility for laying out his work and for any damage caused to the Owner or other sub-contractors by improper location or carrying out of his work.

B. The Contractor shall provide proper guards for prevention of accidents, and provide and maintain any other necessary construction required to secure safety of life or property to secure such protection.

1.13 BYPASS CONNECTIONS

A. The Contractor shall include all costs for removals and relocations in the Contract. These costs shall include work described in the Specifications and shown on the Drawings with allowances for normal unforeseen difficulties when concealed work has been opened. A minimum of 3 bypass connections shall be included. Each bypass connection shall consist of 50 feet of 4 inch EMT conduit with 4 #500 AWG and 1#3 AWG ground conductors, (2) junction boxes, (4) 90 degrees bends, and all appurtenances as required for connections; bypass connections would be Installed 11 feet high in congested area, and be supported from structure above. Include cost of cutting and removal of feeder to be bypassed. Bypass connection installation shall be priced on an overtime schedule basis.

1.14 SHUTDOWNS

A. When installation of a new system or reconnection of an existing system requires the temporary shutdown of an existing operating system, the connection into the existing system shall be performed at such time as designated by the Owner.

B. The Owner shall be notified of the estimated duration of the shutdown period (3) weeks in advance of the date the work is desired to be performed.

C. Work shall be arranged for continuous performance, including overtime, at no extra cost to the Owner to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.15 COORDINATION WITH EXISTING OCCUPIED AREAS

A. Minimize disruptions to operation of building systems in occupied areas.

B. Provide temporary connections to prevent long disruptions.

C. Provide multiple crews, premium time labor and/or shift labor to reduce duration of work and impact on the facility.

D. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such regular time or at overtime when designated by the Owner. Assume all connections to existing operational systems will be on premium time, provide a credit for all work allowed to occur on normal time.

1.16 ENGINEERING BY CONTRACTOR

A. The construction of this work requires the Contractor to perform certain design activities with regard to several of the Contract systems or subsystems that can only be fully ascertained with regard to the prevailing site field conditions during construction activities. All such designs and related activities shall be the complete responsibility of the Contractor. Where these design activities require engineering, it is the responsibility of the Contractor to engage the service of a licensed New York State Professional Engineer experienced in the areas related to the design activities performed by the Contractor.

B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:

1. Any system not fully detailed on the drawings.
2. Fire alarm.
3. Equipment supports, not fully detailed in the drawings.
4. Conduit hangers and anchors not specified in these documents, or cataloged by the manufacturer.
5. Vibration isolators and seismic restraints.
6. Miscellaneous steel as required.
7. Equipment supports, hangers.
8. Pull box and splice box quantities and sizes.

C. Contractor’s design responsibility shall include system design, any required calculations to support system design, any compliance documents or certifications by any governing body up to and including replacement of design engineer with a different engineer of record, retained and paid by the contractor, as determined by authorities or original design engineer.

D. Contractor shall complete all controlled or special inspections and file all required paperwork in a timely manner. Professional engineer retained by contractor to serve as “special inspector” shall meet all requirements for special inspector as determined by the authority having jurisdiction.

1.17 ACCESSIBILITY AND MEASUREMENT

A. All work shall be installed so as to be readily accessible for operation, maintenance and repair. Minor deviations from the plans may be made to accomplish this, subject to the approval of the Engineer/Architect.

B. Before ordering any material or doing any work, the Contractor shall verify all measurements at the Building, and shall be responsible for the correctness of same as related to the work under this Contract.

1.18 NAMES AND TRADE NAMES

A. Where trade and manufacturers' names are specified or indicated on the Drawings, they are intended to indicate the standard of material or articles required. This shall not remove the responsibility of the Contractor from verifying the equipment's compliance with all rules and regulations governing the use of such equipment. No purchase of any equipment shall be done without written authorization, if such equipment will not abide with all rules and regulations, covering its intended use.

1.19 MISCELLANEOUS

A. For watchman, staging, scaffolding, insurance, bond, pumping, rubbish removal, access to work areas, storage on site, and the like, refer to Division 1, General Requirements of these specifications.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment and materials installed shall be new, unless otherwise specified.

B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.

C. All equipment shall be UL listed and bear the UL label.

2.2 GENERAL SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing:

1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
4. The Contractor shall submit shop drawings with such promptness as to cause no delay in his own work or that of another contractor.

B. Preparation of Submittals:

1. Refer to Division 1 requirements.
2. Generator submittals shall include the entire generator specification with the words "Comply" or "No Comply" next to each paragraph. If "No Comply", then state what alternate feature is provided.
3. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submit product submittals on items as outlined in sections hereinafter.
4. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together at one time in a single PDF document. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, electrical room layouts and electrical switchboards), they shall be submitted at the same time.
5. Each individual submittal items within a PDF document shall be marked to show section number which pertains to the item.
6. Provide the following information in each PDF document: project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
7. Submittals not presented in a neat and legible fashion will be returned "Without Action."
8. Submittals shall show Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "Without Action."

9. Provide space for Architect's "Action" marking.

C. Substitutions

1. Refer to the General Conditions, which governs "Substitution" of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.
   a. Explain the reasons for the deviations.
   b. Show how such deviations coordinate with interfacing portions of other work.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

Division 26	Division 27	Division 28
Medium Voltage Cable	Fiber Optic Cabling	Fire Alarm System
Wires and Cables	Telecommunication Backbone Cabling	Security Systems
Grounding	Horizontal Cabling	
Supporting Devices		
Raceways		
Electrical Boxes and Fittings		
Cable Trays		
Underground Service and Manholes		
Vibration Isolation Systems		
Electrical Identification		
Lighting Control Devices		
Architectural Lighting Control		
Network Lighting Control		
Motor Controllers		
Transformers		
Switchboards		
Panelboards		
Wiring Devices		
Motor Disconnect and Fuses		
Diesel Generator Sets		
Transfer Switches		
Lightning Protection Systems		
Transient Voltage Surge Suppression		
Lighting Fixtures		

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:

a. "REVIEWED:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades is the responsibility of the contractor.
b. "FURNISH AS PER COMMENTS:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
c. "REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal does not relieve the contractor from meeting project schedules.
d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal does not relieve the contractor from meeting project schedules.

5. If shop drawings are submitted and returned as "REVIEWED" or "FURNISH AS PER COMMENTS" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."

Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

2.3 GREEN BUILDING REQUIREMENTS AND PERFORMANCE CRITERIA

A. Green Building Performance Criteria:

1. All field-applied concrete admixtures, adhesives, sealants, paints and coatings used for interior applications shall meet the volatile organic compound (VOC) and chemical component limitations as defined in Section 018115 "Limitations on VOC Contents".

B. Green Building Submittal Requirements:

The Contractor and their sub-contractors shall submit the GREEN BUILDING CERTIFICATION items listed herein.

1. GBMCF: Submit a completed GREEN BUILDING MATERIALS CERTIFICATION FORM. A copy of the GBMCF is appended to Section 018113 "Sustainable Design Requirements". Information to be supplied for this form shall include:
   a. Cost breakdowns for the materials included in the Contractor or sub-contractor's work. Cost breakdowns shall include total cost plus itemized material costs for and VOC containing products.
2. Validation: Published product literature or manufacturer's letter of certification (on the manufacturer's letterhead) validating all information, other than costs, provided in the GBMCF.
3. Cut Sheets: Product cut sheets for materials listed in the GBMCF. Cut sheets shall be submitted with the Contractor or Trade Contractor's stamp, confirming that the submitted products are the products installed in the Project.
4. VOC Content: Material Safety Data Sheets (MSDS), published product literature, or manufacturer's signed certification (on manufacturer's letterhead) stating the VOC content of all applicable products.
5. Submittal Package: The GREEN BUILDING submittal information shall be assembled into one (1) package per Section or trade, and sent to the Consultant for review. Incomplete or inaccurate Green Building submittals may be used as the basis for rejecting the submitted products or assemblies.

2.4 PROTECTION, MAINTENANCE AND PRODUCT HANDLING OF ELECTRICAL EQUIPMENT

A. Electrical equipment shall be delivered and stored at the site, properly packed and crated until finally installed. Store materials in spaces as designated by the General Contractor. Investigate each space through which equipment must be moved. If necessary, equipment shall be shipped from manufacturer in crated sections of size suitable for moving through restricted spaces.

B. Uninstalled and installed equipment and materials shall be adequately protected against loss or stealing, damage caused by water, paint, fire, plaster, moisture, acids, fumes, dust or other environmental conditions, or physical damage, during delivery, storage, installation and shutdown conditions. This Contractor shall replace any damage or stolen material without extra cost to the Owner.

C. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions of temperature in area of moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

D. This Contractor shall be responsible for the maintenance of all equipment and systems installed, until final acceptance by the Architect and the Owner. The Operation of the equipment by the Owner does not constitute an acceptance of the work. Work will be accepted only after the Contractor has adjusted his equipment, demonstrated that it fulfills the requirements of the Drawings and Specifications, and has furnished all required certificates.

E. This Contractor shall guarantee in writing to the Owner that all work installed by him shall be free of defects in workmanship and materials and that all apparatus will develop the capacities and characteristics as indicated, and that, if during a period of one year from date of final approval of work by the Architect, any defects in workmanship, materials or performance appear, he will remedy them without any cost to the Owner. Guarantee requirements shall consist of the aforestated and other requirements, as established under applicable contract documents.

F. Provide effective protection against damage for all material and equipment during shipment, and storage at the Project Site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.

G. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.

H. Protect all rough and finished floors and other finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor covering. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

I. Have materials delivered to site. Unload and store materials in designated location, and protect from damage. Deliver materials to their point of installation.

J. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

2.5 NAMEPLATES

A. Furnish a nameplate for each separately installed feeder, switch and circuit breaker, each individual panel, transformer, disconnect switch, push-button station and equipment enclosure.

B. Unless otherwise noted, nameplates shall be black laminate with white letters of uniform size consisting of reasonably large caps, easily visible.

C. Inscriptions shall consist of name and number of equipment as shown on the Drawings and as approved by the Architect.

2.6 HAZARDOUS LOCATIONS

A. As indicated.

*** OPTION 1 - NEC:**

1. Provide material, equipment and installation as required for Class, Division and Group noted.

PART 3 – EXECUTION

3.1 CONDITIONS AT SITE

A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not. Verify all grades, elevations, dimensions, and clearances at the site.

B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.

C. Examine all work prepared by others to receive the work of this Section and report any defects affecting installation to the General Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.2 LICENSES, FEES AND PERMITS

A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation and deliver to Architect.

B. This work shall include the procurement of and payment for all permits, certificates and fees for the performance of the electrical work in compliance with codes, applicable laws and municipal regulations including those from local utilities for services.

3.3 MATERIAL, WORKMANSHIP, AND CONTRACTOR'S QUALIFICATIONS

A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.

C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.

D. All material shall be new and of the best quality and shall have the Underwriters Laboratories label attached. The Label shall be of the type for the intended application. The work throughout shall be executed in the best and most thorough manner under the direction of, and to the satisfaction of the Architect who will interpret the meaning of the Drawings and Specifications. The Architect shall have the power to reject any work and materials which, in his opinion, is not in full accordance therewith.

E. If, after installation, operation of the equipment proves to be unsatisfactory to the Owner by reason of defects, errors or omissions, the Owner reserves the right to operate equipment until it can be removed from service for correction by Contractor. Contractor shall pay for damages to work of other trades caused by this defective equipment and its replacement.

3.4 SUPERVISION AND COORDINATION

A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.

B. The work of this Section shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of each respective work wherein it may be interrelated with that of this Contract so that generally all construction work can proceed in its natural sequence without unnecessary delay. All communications of a coordinating nature to the Architect shall be via the General Contractor.

C. Examine all Architectural, Structural, Heating, Ventilating and Air Conditioning, Sprinkler and Plumbing Drawings relating to this Project, and verify all governing conditions at the site and become fully informed as to the extent and character of the work required and its relation to other work in the building. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or work to be done.

D. Scaled and figured dimensions with respect to the items are approximate only; sizes of equipment have been taken from typical equipment items of the class indicated. Before proceeding with work, the Contractor shall carefully check all dimensions and sizes and shall assume full responsibility for the fitting-in of equipment and materials to the building and to meet architectural and structural conditions. Discrepancies shall be reported to the Architect in ample time to prevent delays or unwarranted changes to work.

E. Coordinate work with other disciplines. Confer with other contractors whose work might affect this installation, and arrange all parts of this work and equipment in proper relation to the work and equipment of others, with the building construction and with architectural finish so that this work will harmonize in service, appearance, and function.

F. Exposed piping shall be installed to provide the maximum amount of headroom but in no case shall piping be installed less than seven feet (7'-0") above the finished floor. Piping installed in areas where hung ceilings or other furred spaces are indicated shall be installed concealed.

G. The Contractor is referred to the Architectural drawings for locations and types of hung ceilings and furred spaces.

H. The Contractor shall have competent supervision on the site at all times to layout, check, coordinate and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades to prevent interference.

I. The Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy.

3.5 RELATED WORK SPECIFIED ELSEWHERE

A. The following items of materials and labor will be provided by other contractors under other Sections of the Specifications and shall be excluded from the work to be furnished by this Contractor:

1. Furnishing of Power (Service) Transformers, and other service equipment as noted in Electrical Service System.
2. Furnishing of Metering Current Transformers and Metering Equipment.
3. Furnishing and setting of motors, adjusting thermal elements and replacing thermal overloads if necessary. Supplying of (Motor Control Centers) individual starters and control devices, unless specifically indicated otherwise.
4. Installation of electric valves, float switches and pressure and pneumatic-electric switches, stats and related control devices, sprinkler devices.
5. Control wiring for boiler and fuel burning not hereinafter specified or shown on Drawings.
6. Furnishing and installing HVAC Temperature Control Boards, Supervisory Temperature Control and Energy Management Systems.
7. Furnishing and installing diesel fuel oil piping, underground storage tank and exhaust piping for emergency generator. Installation of silencer, daytank and flexible connections.

8. Installation of day tank and transfer pump, muffler and flexible connectors.
9. Furnishing of surgical lights, stationary X-ray equipment, and film illuminators.
10. Installation of duct type smoke detectors.
11. Furnishing and installing telephone company cables and instruments.
12. Base flashing for conduits passing through roof.
13. Setting of access doors in walls and ceilings.
14. Furnishing of alarm and supervisory devices for Sprinkler Alarm System.
15. Rough and finish patching.
16. Finish painting of exposed conduits, boxes, hangers, apparatus, etc.
17. Openings for sleeves in foundation walls below grade and floor slabs when noted on foundation Drawings or in foundation Specifications.
18. Dewatering of trenches outside of Building.

3.6 TESTING

A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

3.7 PROGRESS OF WORK

A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

3.8 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section “Cutting and Patching.” In addition to the requirement specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
   a. Uncover work to provide for installation of ill-timed work.
   b. Remove and replace defective work.
   c. Remove and replace work not conforming to requirements of the Contract documents.
   d. Remove samples of installed work as specified for testing.
   e. Install equipment and materials in newly installed structures.
   f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

3.9 SLEEVES

A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26, 27 and 28. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

3.10 EXCAVATION, TRENCHING, AND BACKFILLING

A. Perform all excavation to install conduit and duct banks indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is

received from the Architect.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits or duct bank on undisturbed soil at every point along its entire length. Tamp over depths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12” below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale. These materials should be free from large clods of earth and stones, deposited in 6” layers and rammed until the installation has cover of not less than the adjacent ground but not greater than 2” above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

D. In addition, all excavation and backfilling shall comply with Division 2. The most stringent requirement shall apply.

3.11 LOAD BALANCE

A. Connect branch circuits to panelboards, and panelboards to feeders so that loads are balanced among the phases within practical limits on the basis of connected load.

B. Branch circuit numbers shown on the drawings are for identification only and do not necessarily indicate the final position of the branch circuits in the panelboards

3.12 MOISTURE-DAMP PROTECTION

A. Wherever any electrical components such as: panels, raceways, etc will be in contact with surfaces which may become damp or wet, spacers to hold electrical work 1/4" (.006m) away from such surfaces shall be provided.

3.13 CLEANUP

A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.14 TEMPORARY LIGHTING AND POWER

A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with general contractor prior to bid for special lighting and power outlets and provide as needed. All temporary power and lighting feeders and branch shall have over-current protection.

B. Electrical services for temporary light and power shall be [obtained from the nearest existing normal switchboard or panelboard and extended as required. Consult the Owner prior to making any connections to existing services. OR arrange with utility company for temporary power connection or generator. Exact size of temporary power required shall be field coordinated by the contractor.]

C. The Electrical Contractor shall furnish, install and maintain the temporary lighting and power system for all Contractors. The use of electricity shall be kept to a minimum.

D. The Owner or Owner's Representative will pay for all energy required by the temporary lighting and power system.

E. Provide all wiring, supports, lamp sockets, receptacle sockets and any other materials, supplies or equipment necessary for temporary light and power system.

F. Ground fault protection required by OSHA for temporary receptacle circuits shall be accomplished by providing branch circuit panels containing ground fault protection branch circuit breakers.

G. Provide a grounding conductor connection to each receptacle grounding terminal. Minimum size branch circuit and ground conductors shall be No. 12 AWG.

H. Install separate stringer circuits for lighting and receptacles. Provide one lamp socket and one duplex receptacle (or two single receptacles) for every 400 square feet of new general construction area. (Approximately 20 feet on centers). Furthermore, provide one lamp socket and one duplex receptacle every 20 feet along the peripheral walls of the construction areas for temporary conditions. Each lamp socket shall be provided with a 100 watt lamp. Replace burned out lamps as required for as long as the temporary lighting system is maintained in operation.

I. Provide sufficient supplementary temporary lighting to permit proper execution of the work. This supplementary lighting shall consist of but not be limited to the following:

1. Construction hoist landings.
2. Stairways and stairway landings where existing illumination is inadequate due to alterations or construction.
3. Interior rooms not covered with general construction area lighting.
4. Provide temporary lighting on construction barriers if barriers block lighting in existing spaces. Provide temporary emergency lighting per code required distances if emergency lighting is obstructed by construction barriers.

J. Provide power wiring to operate construction hoist. Provide fused disconnect switch at hoist location. Fuse size, wiring size and disconnect shall be as required.

K. Provide 50 trailer extension cords, each 25 feet long. Cords shall be 16-3, Type SJ. 25 of the trailer cord sets shall be receptacle type ITT No. 6112 and 25 of the trailer cord sets shall be trouble light type with receptacle ITT No. J-3270.

L. Keep the temporary lighting and power system operational commencing fifteen (15) minutes before the established starting time of that trade which starts work earliest in the morning and ending fifteen (15) minutes after the established quitting time of that trade which stops work latest in the evening. This applies to all weekdays, Monday through Friday inclusive, which are established as regular working days for any trade engaged in the work, and shall continue until Final Acceptance of the work or until these services are ordered terminated by the Owner or the Owner Representative.

M. Any or all of the temporary services herein specified shall be disconnected, removed, or relocated when its or their use is no longer required, or if it or they should impede the progress of the work, and as requested by the Construction Manager and/or General Contractor. Should a change in location of any temporary equipment herein specified be necessary to progress the work, the contractor shall remove and relocate such equipment as directed by the Construction Manager and/or General Contractor at no additional cost to contract. The temporary equipment herein specified shall be removed and disposed of when directed by the Construction Manager and/or General Contractor.

N. Any Contractor requiring overtime use shall reimburse the Electrical Contractor by private agreement between Contractors.

O. Provide construction site lighting as required or directed. This lighting shall be mounted on shanties and shall be wired on separate circuits to permit illumination from dusk to dawn.

P. Immediately upon activation of permanent service, the contractor shall distribute temporary power from the permanent service.

Q. It is the intent of these specifications to generally indicate to the contractor the scope and requirements of temporary light and power. It is understood that these requirements shall vary during construction as required by field conditions, etc and as directed by the Construction Manager and/or General Contractor. It shall be the responsibility of the Contractor to adjust and modify the temporary wiring requirements accordingly.

3.15 MINOR CHANGES

A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.16 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

A. Testing

1. Refer to the individual specification sections for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. Six (6) typewritten copies of the tests shall be submitted to the Architect/Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers' Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.
2. Provide manufacturers' certification for the emergency generator set/automatic transfer system, architectural lighting control, network lighting control, fire alarm system and lightning protection.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Architect/Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e., panelboard trims, switchboards, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.17 ADVISORY BOARD

A. The electrical contractor shall be responsible for filing the service equipment layout with the City of Poughkeepsie, New York Advisory Board.

B. All drawings shall be in a form acceptable to the Advisory Board.

C. Contractor shall pay all required filing fees.

3.18 COMMISSIONING

A. After startup and testing of each system has been completed, the Owner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.

B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.

C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

END OF SECTION

SECTION 26 05 03

TESTING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.

1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
3. The tests and inspections shall determine suitability for startup and energization.
4. The following equipment shall be tested and or calibrated:

Low Voltage Power Wires and Cables - Section 26 05 19
Medium Voltage Cables - Section 26 05 13
Grounding - Section 26 05 26
Low Voltage Transformers - Section 26 22 00
Switchboards - Section 26 24 13
Panelboards – Section 26 24 13
Diesel Generator Set - Section 26 32 13
Automatic Transfer Switch - Section 26 36 00

1.2 SUBMITTALS

A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 02.

B. Qualification of testing firm.

C. Submit PDF copies of certified test reports to Engineer for approval.

D. PDF copies of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.

B. The Contractor shall test all lighting, low voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.

C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.

D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.

E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This study shall be submitted with

electrical equipment submission and electrical room layouts.

F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.

G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.

J. Prior to performing tests, the contractor shall notify the Architect a minimum of one week in advance, so that the Architect may schedule a representative to be present while tests are being conducted.

K. Any defects shall be corrected at once, and the tests reconducted.

L. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

M. The tests shall be performed by competent personnel and shall demonstrate the following:

1. That all lighting, power and control circuits are continuous and free from short circuits.
2. That all circuits are free from unspecified grounds.
3. That all connections within panelboards are tight and do not produce excess heating.
4. That the resistance to ground of all non-grounded circuits is not less than one megohm.
5. That all circuits are properly connected in accordance with the applicable wiring diagrams.
6. That all circuits are operable by which a demonstration shall include functioning of each control not less than three times and continuous operation of each lighting and power circuit for not less than 1/2 hour.
7. That all alarm and signal systems and all emergency and exit lights are properly functioning.

N. When wiring systems are "megger" tested, the insulation resistance between conductors and between conductors and grounds, based on maximum load, shall not be less than that required by Electrical Code and local authorities having jurisdiction.

O. A digital copy of record of all test data shall be supplied to the Architect (three copies). The tests shall cover but not be limited to the following:

1. Primary service and distribution system.
2. Secondary service and distribution system.
3. Emergency equipment and distribution system.
4. Fire alarm, sprinkler and smoke detection systems.
5. All communications, signaling and alarm systems.
6. Power installations and motor controls.
7. Light installations and circuit switching.
8. Any part of the work called for in the Specification, or Drawings and as designated by the Architect or Engineers.

P. If in the opinion of the Architect, the results of such tests show that the work has not complied with the requirements of the Specifications or Drawings, the Contractor shall make all additions or changes necessary to put the system in proper working condition and shall pay for all the expenses and for all subsequent tests which are necessary to determine whether the work is satisfactory. Any additional work or subsequent tests shall be carried out at the convenience of the Owner, prior to final payment.

1.4 QUALIFICATIONS OF TESTING FIRM

A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).

D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.

E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current New York State stamp.

F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.

G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991
5. American National Standards Institute - ANSI C2: National Electrical Safety Code
6. State and City of Poughkeepsie Codes and Ordinances
7. Insulated Cable Engineers Association - ICEA
8. Association of Edison Illuminating Companies - AEIC
9. Occupational Safety and Health Administration - OSHA
10. National Fire Protection Association - NFPA
    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 78: Lightning Protection Standard
    e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:

1. Project design specifications.
2. Project design drawings.
3. Short-circuit and coordination study.
4. Manufacturer's instruction manuals applicable to each particular apparatus.
5. Project list of equipment to be inspected and tested as stated above.

PART 2 - SHORT-CIRCUIT AND COORDINATION STUDY

2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified electrical power distribution system. This analysis shall include:

A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.

B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.

C. The study shall be calculated from the utility meter to the unit substation to the lowest overcurrent device or equipment on the electrical distribution system. The utility conductors shall not be used for calculations.

D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.

E. Provide five copies of the short-circuit analysis for the engineer's approval within 60 days of contract award.

F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.

G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.

H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.

I. A table of equipment short-circuit ratings versus calculated short-circuit current values.

J. The short circuit and coordination study shall be completed and forwarded for review within 120 days after award of the contract.

K. At the time of the final inspection and tests, all connections at the panels and all splices, etc., must have been completed. All fuses must be in place and the circuits continuous from service switches to all receptacles, outlets, motors, etc.

L. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner. Where approved by the Engineer.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

The electrical equipment manufacturer shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:

A. A determination of settings or ratings for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of a digital computer.

B. An evaluation to the degree of system protection and service continuity possible with overcurrent devices supplied.

C. Provide five copies of the protective device time-current coordination analysis for the Engineer's approval.

D. Log-Log plots of time-current characteristic curves.

E. A tabulation of the suggested settings of the adjustable overcurrent protective devices supplied.

F. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the setting or ratings of the overcurrent protective devices supplied.

G. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.

H. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

2.3 ARC FLASH HAZARD ANALYSIS

A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

A. Testing firm to provide and comply with the following:

1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
2. Refer to each individual specification section for testing requirements and comply.
3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

A. General:

1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
2. Implementation:
   a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
   b. Test all interlock devices, and trip settings on breakers.
   c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION

SECTION 26 05 05

MANUFACTURERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following lists of manufacturers are for the specifications as identified.

B. All submittals and documentation shall be in accordance with the project General Requirements, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. All manufacturers not listed shall be pre-approved prior to bid in order to be considered. Refer to Division 1 for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Identification	26 05 53	Ideal Industries, Inc. National Band and Tag Co. Panduit Corp. Seton Name Plate Co. W.H. Brady, Co.
Raceways		
Conduit & Tubing	26 05 33	Alflex Div.; Southwire Co. Allied Div.; Atkore Carlon, Inc. Liquatite Div.; Electri-Flex Wheatland Tube Co.
Conduit Bodies	26 05 33	Appleton Div.; Emerson Electric Crouse-Hinds Div.; Eaton Killark Div.; Hubbell Inc. OZ/Gedney Div.; Emerson Electric Steel City Div.; Thomas & Betts

TITLE	SPECIFICATION SECTION	MANUFACTURER
Wireway & Enclosures	26 05 33	B-Line Div.; Eaton Hammond Mfg. Hoffman Div.; Pentair Square D Div.; Schneider Electric
Surface Raceways	26 05 33	Hubbell Inc. Isoduct Div; Legrand Square D Div.; Schneider Electric Wiremold Div.; Legrand
Wire and Cables Medium Voltage Cables	26 05 19 26 05 13	General Cable Okonite Co. Kerite Pirelli
Electrical Boxes & Fittings		
Raintight outlet boxes	26 05 34	Appleton Div.; Emerson Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Steel City Div.; Thomas & Betts
Bushings, knockout closures and locknuts	26 05 34	Appleton Div.; Emerson Electric Midwest Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Wiring Devices		
Receptacles & Switches Dimmers	26 27 26 26 27 26	Hubbell, Inc. Arrow Hart Div.; Eaton Leviton Lightolier Lutron Wattstopper
Supporting Devices		
Slotted metal Angle & U-channel Systems	26 05 29	American Electric B-Line Div.; Eaton Unistrut Div.; Atkore
Conduit Sealing Bushings	26 05 29	OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Switchboards & Panelboards	26 24 13 and 26 24 16	Cutler-Hammer Div.; Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Transformers	26 22 00	Cutler-Hammer Div.; Eaton General Electric Company Hammond Power Solutions Siemens (I-T-E-) Square D Div.; Schneider Electric

TITLE	SPECIFICATION SECTION	MANUFACTURER
Liquid Filled Medium Voltage Transformers	26 12 13	Cooper Industries Div.; Eaton Howard Industries General Electric Company Solomon Corporation Square D Div.; Schneider Electric
Motor, Disconnects and Fuses		
Circuit and Motor Disconnects	26 28 16	Cutler-Hammer Div.; Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Fuses (See Note)	26 28 16	Bussmann Div.; Eaton (Basis of Design) Mersen
Connections	26 28 16	Appleton Div.; Emerson Electric Burndy Corp. Ideal Industries, Inc. Thomas & Betts
NOTE: Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		
Motor Controllers	26 29 13	Allen-Bradley Div.; Rockwell Automation Cutler-Hammer Div.; Eaton Siemens Square D Div.; Schneider Electric
Surge Protection Devices	26 43 13	Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Lightning Protection-Multi-Point	26 41 15	Erico Lightning Protection Heary Brothers National Lightning Protection
Grounding	26 05 26	Burndy Electrical Cadweld Div.; Erico Ideal Industries Okonite
Lighting Fixtures	26 51 00	Refer to Drawings
Pole and Standards		
Metal Poles	26 56 13	Millerbernd Mfg. Co. Union Metal Mfg. Co. Valmont Industries, Inc.
Pole Hardware	26 56 13	A.B. Chance Div.; Hubbell Inc. Lithonia Lighting Div. MacLean Power Systems McGraw-Edison Div.; Eaton Preform Line Products Co. Reliable Electric Co. Utilities Service Co.
Network Lighting Controls	26 09 43	General Electric Lighting Leviton

TITLE	SPECIFICATION SECTION	MANUFACTURER
Architectural Lighting Control	26 09 33	Crestron ETC Lutron
Diesel Generator Sets	26 32 13	Caterpillar Cummins Kohler
Automatic Transfer Switches	26 36 23	ASCO Russ Electric, Inc. Zenith Div.; General Electric Company
Addressable Fire Alarm System	28 31 00	Fire Control Instruments; Notifier; Microm
Occupant Sensors	26 51 01	Honeywell Hubbell Inc. Leviton Lightolier Lutron Watt Stopper

PART 3 - EXECUTION - Not Used.

END OF SECTION

SECTION 26 05 06

BASIC MATERIAL AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

A. Materials list with manufacturer, style, series or model identified.

B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Refer to Section 26 05 05.

2.2 CONDUIT RACEWAYS: Refer to Section 26 05 33.

2.3 WIRES AND CABLES: Refer to Section 26 05 19.

2.4 MEDIUM VOLTAGE CABLE: Refer to Section 26 05 13.

2.5 WIRING DEVICES: Refer to Section 26 27 26.

2.6 OUTLET BOXES, JUNCTION AND PULL BOXES

A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.

B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, galvanized where required for outdoor exposure.

C. All exterior boxes shall be cast, gasketed, weatherproof type with cast covers.

D. Refer to Section 26 05 34 for additional requirements.

2.7 WIRE CONNECTORS

A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.

B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.8 CONDUIT HANGERS

A. Galvanized steel with special accessories for purpose and adequate to support load imposed. Support individual conduit 1-1/2-inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.

B. Refer to Section 26 05 29 for additional requirements.

2.9 FUSES: Refer to Section 26 28 16.

2.10 ACCESS PANELS

A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.11 TERMINAL CABINETS AND BACKBOARDS

A. Fabricate from code gauge steel, size as indicated on drawings, with flush latch and concealed hinge. Where size is not indicated, minimum size shall be 20" wide x 24" high x 4" deep. Finish shall be ANSI 61 light gray baked enamel.

B. Provide inside terminal cabinet, ¾" thick plywood backboard and terminal strips, one terminal point for each wire within the terminal cabinet.

C. Provide ¾" thick plywood backboards, size as indicated on drawings, for telephone where indicated on drawings.

2.12 CONDUIT SLEEVES

A. Sleeves for Conduit Penetration: Pipe Shields, Inc., model WFB at walls and QDFB at floors. Refer to Division 7 "Firestopping" for additional requirements.

2.13 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless steel type hardware shall be used.

B. Refer to Section 26 05 29 for additional requirements.

2.14 PREFABRICATED CURBS

A. General: Except where curbs are provided with equipment, provide prefabricated curbs for all roof mounted equipment and conduit.

B. Manufacturers:

1. Design Basis: Pace
2. Other Acceptable Manufacturers:
   a. Thycurb

C. Coordinate with roofing Contractor. Exterior insulation, cants, flashing and counter flashing shall be furnished and installed under roofing work, Division 7.

D. Model: As required.

E. Roof Curbs

1. Roof curbs shall have a minimum height of 6” or as specified on the drawings, whichever is greater.

2.15 EQUIPMENT SUPPORTS

A. Provide housekeeping pads for all floor mounted equipment.

1. Housekeeping pads shall have a minimum height of 4” or as specified on the drawings, whichever is greater.
2. Provide pins to tie new pad to existing floor.
3. Provide rebar within new pad to support equipment load and prevent cracking of pad.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide complete raceway systems for all conductors including control wiring and low voltage wiring unless otherwise noted.

B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAY: Refer to Section 26 05 33.

3.3 OUTLETS

A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.

B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4” octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8” no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4” square box with tile ring in masonry walls which will not be plastered or furred, or where “dry-wall” type materials are applied. Through the wall type boxes are not permitted. Install minimum 12” lateral separation for back to back boxes.

C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds condulets or equal).

D. Dimensions, unless shown on drawings, are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4’ - 0” (to top of switch)
Convenience outlets	1’-6” (to bottom of outlet)
Receptacle outlets in mechanical spaces	3’ – 0” (to bottom of outlet)
Hallways	1’ - 6” (to bottom of outlet)
Workroom wall outlet	4’ - 4” (field verify height of backsplash)
Panelboards wall-mounted	6’ - 6” (to top of trim)
Wall phone outlet	4’ - 0”
Telephone outlets	1’ - 6”
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4’ - 0” (to top of device)
Fire alarm strobes	6’ - 8” or 6” below ceiling (whichever is lower)
Television outlets	Refer to A/V or architectural drawing
Clock outlet	8'-3" or 1'-0" below fin. ceiling
Receptacles at counters	4’-0” or as required.
Motor controllers	5’-0”
Safety and disconnect switches	5’-0”

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscotting, shall be at a height to prevent interference to service equipment, or as noted on drawings.

F. Refer to Section 26 05 34 for additional requirements.

3.4 JUNCTION PULL BOXES

A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as “Cabinets,” with screw covers of same gauge metal. Removal covers must be accessible at all times.

B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

END OF SECTION

SECTION 26 05 07

FOOD SERVICE EQUIPMENT WIRING

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide food service equipment wiring, complete, as shown and specified per Contract Documents.

B. Related Sections: The following Sections apply to Work under this Section.

1. Division 26 Section “Electrical Requirements” and “Basic Material and Methods”.

1.2 GENERAL

A. Obtain and verify electrical requirements and location of food service equipment prior to installation of related electrical Work.

PART 2 - PRODUCTS (Refer to Section 26 05 06 “Basic Material and Methods.”)

PART 3 - EXECUTION

3.1 FOOD SERVICE EQUIPMENT WIRING

A. All final connections to equipment by Electrical Contractor.

B. All electrical lines shall be extended from rough-in to connection point or points on the fixture by the Electrical Contractor furnishing all labor and materials.

C. Where electrical lines are shown out of floor on drawings, Electrical Contractor shall stub up 6" above finished floor and connect, after equipment has been set in place and leveled by Kitchen Equipment Contractor (KEC).

D. All rough-ins shall be concealed in walls or columns wherever possible.

E. All fabricated equipment shall be completely wired internally, and all electrical outlets and receptacles mounted on or in fabricated equipment shall be furnished and installed by KEC who shall run all lines to suitable terminal boxes or subpanels; starters or disconnect switches by Electrical Contractor. Final connection shall be made by the Electrical Contractor. Where equipment wiring terminates in a junction box, switch, or terminal box, the Electrical Contractor shall make all connections between the branch circuit and equipment wiring. Where terminal is a receptacle, connect branch circuit to receptacle. Where terminal is a sub-panel, connect branch circuit to the mains of the sub-panel. All receptacles shall be furnished by Electrical Contractor, except those which are built into an item of equipment.

F. All plug-in equipment receptacles shall be polarized. The Electrical Contractor shall provide the appropriate grounding type receptacles for all wall- and floor-mounted outlets to be used for plug-in equipment as noted on the drawings, with characteristics as noted. All plug-in equipment shall have the appropriate cord and plug set furnished and installed by the KEC. The KEC and Electrical Contractor shall coordinate their work so that the receptacles provided will match the specific plugs installed as part of the plug-in equipment, and any changes in cords and plugs

or receptacles required in the field will be done at no cost to the Owner.

G. The Electrical Contractor shall provide power and control wiring in the field between various equipment components as required, such as, but not limited to, ventilator control panels to ventilators, fans and detergent systems, and disposer control panels to disposer motors and solenoids.

H. Electric switches with thermal overload protection will be mounted on the dishwashing machine by KEC or dishmachine manufacturer. Machine may be shipped to the job site in one or more sections. After machine is assembled by the KEC, the Electrical Contractor shall interconnect machine sections and provide final connections.

I. The KEC shall supply, one each motor-driven appliance or electrical heating unit, a suitable control switch or starter of the proper type in accordance with Underwriter's Laboratory requirements wherever such switch or starter is not furnished integrally with the equipment by its manufacturer. All other line switches; safety cut-outs; disconnect switches; control panels; fuse boxes; other controls, fittings, and connections, when not an integral part of the unit, will be furnished and installed by the Electrical Contractor.

J. All conduit, junction boxes, and other fittings for equipment which is freestanding, or open tubular construction, exposed to public view, shall be stainless steel or chrome- plated. Assemblies in non-public areas shall be epoxy-painted aluminum.

K. The Electrical Contractor shall supply power and interconnecting services and all final connections to walk-in refrigeration and freezer compressor/condensers and evaporators, solenoid valves and switches required for a complete operating system. Furnish and install a disconnect switch for each compressor. Walk-in refrigerator lights shall be furnished by the KEC and installed and fully connected by the Electrical Contractor. Exposed conduit inside the walk-in compartment is unacceptable.

L. The Electrical Contractor shall furnish and install control wiring between refrigeration temperature alarm systems and remote monitoring panel.

M. "Sealtite" type flexible conduit shall be used for all flexible conduit installations, depending on code requirements. Junction boxes for equipment requiring flexible conduit should be mounted right on conduit at elevations which will limit the total length of the flexible conduit to 24" overall.

N. Sleeve collars shall extend 2" above top of the finished floor. Openings between collar and conduit shall be sealed watertight.

O. Electrical Contractor shall connect electrical supply from rough-in location to the disposer control panel and then to the disposer motor and solenoids. Control panel contains overload and under-voltage protection and fused disconnect switch.

P. The KEC shall provide microswitches as part of the fire suppression system, which, when wired to, will allow for the interruption of power to all electrically operated equipment as required in case of fire. Power source for the fire suppression system shall be interwired to an emergency generator or external battery system by the Electrical Contractor so that the fire system will remain energized in the event of a power failure. The Electrical Contractor shall provide adequate contactors, shunt-trips, or other equipment to interrupt power as required by code and inter-wire with system as supplied by KEC. (If Utility Distribution System is specified, shut-offs will be provided by KEC as part of the system and the Electrical Contractor will need to interwire from the microswitch at the fire suppression system tanks to the terminal block in the system.)

Q. Electrical Contractor shall interwire ventilator exhaust and washdown system per directions of KEC and manufacturer. The ventilator control system shall be interwired to an emergency generator or external battery system so that the ventilator system is constantly energized in the event of a power failure.

END OF SECTION

SECTION 26 05 10

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Certifications
5. Record drawings
6. Permit requirements

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for life safety systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.

B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

- ☐ The following tests have been completed. Submit test report for record.
  - ☐ Feeder Testing and Reporting (Megger Result)
  - ☐ Medium Voltage cable Testing and Reporting
  - ☐ Transformers Testing and Reporting
  - ☐ Grounding System Testing and Reporting
  - ☐ Diesel Generator Testing and Reporting
  - ☐ Secondary Switchboard Infrared Scans, Testing and Reporting
- ☐ All main components of the electrical system cleaned and vacuumed. This includes unit substations, switchboards, distribution boards, panel boards, etc. Provide M-E Engineers with schedule when this is going to occur and a letter stating it has been completed.
- ☐ The contractor shall schedule a walk through with the engineer to inspect all main feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.
- ☐ Temporary cable tray hooks inspected.
- ☐ Fixtures re-lamped per specifications.
- ☐ The fire alarm system manufacturer shall provide the Owner/Architect with a “Letter of Certification” indicating the system is fully functional and meets all manufacturers requirements as well as code and design requirements. Fire department must sign off the system.
- ☐ Provide spare fuses and fuse cabinets ((1) in each switch gear room) per specifications.
- ☐ Panelboard directories completed.
- ☐ Record drawings submitted.
- ☐ All lighting control systems complete with controls fully operational for visual inspections.
`
- ☐ The lightning protection system manufacturer shall provide the Owner/Architect with a “Letter of Certification” indicating the system meets all manufacturers requirements as well as code and design requirements.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 LIFE SAFETY SYSTEMS

A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.

B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.

C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

A. The Division 26 contractor shall coordinate his requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

3.4 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

SECTION 26 05 11

ELECTRIC SERVICE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, electrical service as shown on the drawings and hereinafter specified.

B. Equipment and wiring shall be provided and installed in part by Central Hudson referred to as Utility Company and in part under this contract.

1.3 SUBMITTALS

A. Materials list with manufacturer, style, series or model identified.

B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Firms with at least 5 years successful installation experience on projects utilizing switchboards and panelboards similar to those required for this project.

B. All work shall be performed in accordance with all rules, regulations, and standards of Utility Company, and all applicable codes.

C. Where deemed necessary, perform all work under the supervision of the Utility Company representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store equipment in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.

B. Handle equipment carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of property line box, enclosures and all required appurtenances with the utility company.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Refer to Section 26 05 05.

2.2 CONDUIT RACEWAYS: Refer to Section 26 05 33.

2.3 WIRES AND CABLES: Refer to Section 26 05 19.

2.4 MEDIUM VOLTAGE CABLE: Refer to Section 26 05 13.

2.5 PULL BOXES: Refer to Section 26 05 06.

2.6 WIRE CONNECTORS: Refer to Section 26 05 06.

2.7 CONDUIT HANGERS: Refer to Section 26 05 06.

2.8 CONDUIT SLEEVES: Refer to Section 26 05 06.

2.9 EQUIPMENT MOUNTING AND SUPPORT HARDWARE: Refer to Section 26 05 06.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. The following work shall be performed by the Utility Company:

1. Service wiring as noted.
2. Supply metering transformers.
3. Supply and install watt hour and demand meters.
4. Final connections to metering equipment.

B. The following work shall be performed by the Contractor.

1. Arrange with the Utility Company for service facilities and pay all charges.
2. Extend service from Utility Company termination.
3. Provide property line box.
4. Provide outdoor metering enclosure.
5. Provide sleeves for service entrance raceways.
6. Metering transformer enclosures and meter pans.
7. Install metering transformers.
8. Meter wiring except final connections
9. Obtain Utility Company approval for all electric service work and service equipment shop drawings.
10. Obtain local review board / inspector approval for all electric service work and service equipment shop drawings.
11. Provide all associated installation components and accessories.

3.2 SERVICE EQUIPMENT AND CONNECTIONS

A. Service and meter equipment indicated on the drawings or the service layouts of the utility company, shall be furnished and installed complete with all connections.

B. Contractor shall apply and receive from the utility company all information relative to the requirements for property

line splice boxes, meter pans, meter blocks, all metal enclosures, current transformer cabinets, meter loops, service wiring, etc.

C. The contractor shall note that after the contract award, the final approved equipment, current transformer cabinet and meter provisions, including property-line box and end-line boxes shall be of the type which includes terminating devices (crab-joints) and protective devices (limiters), connections, hardware, etc.

D. Any work the utility company performs as part of this installation which is chargeable to the project shall be paid for by this contractor as part of this Contract.

3.3 TYPE OF ELECTRIC SERVICE

A. Unless otherwise noted, the voltage supply for this building shall be the standard electric service 480/277V, 3 phase, 4 wire, 60 Hz Alternating Current Service.

B. If 480/277 volt, then provide ground fault sensing and tripping on all mains 1000 Amps or more.

3.4 LIMITER LUGS

A. In the service end-line box, furnish and install straight line limiter lugs on each conductor of each phase of the incoming secondary service feeder, if required by the utility company.

B. Limiter lugs shall have proper link element characteristics, based on applicable cable size that will carry normal overloads of short duration, but will clear on overloads liable to damage cable insulation.

C. Limiters shall have heat resistant shell to confine the arc and insulating sleeve. Provide sufficient cable slack for replacement for at least one unit per phase.

D. Limiter lugs shall be equal to Burndy type YFS-CR.

3.5 METER CABINETS, ETC

A. Cabinets of meter pans, current transformers, service switches, and all other service equipment shall be constructed from galvanized or other approved rust resistant steel or aluminum and shall be painted on all exposed surfaces with a priming coat and a coat of paint (color as selected). Cabinet doors shall have steel hinges and non-ferrous pins.

3.6 MOUNTING OF SERVICE EQUIPMENT, ETC

A. Service equipment shall be mounted a minimum of ½" out from wall. Lightweight equipment may be mounted on spacers, while heavy equipment shall be fastened to wall by using suitable metal framework.

B. The various elements of the service equipment, such as service switches, cutouts, metering equipment with conduit and cable connections are indicated diagrammatically on the drawings. Contractor may re-arrange and/or group the various elements including main distribution panel where practical using separate or common wireways or equivalent built-in gutters for cable or copper bus connections in one or more cabinets with separate access doors to fit space available.

C. Each unit of equipment shall be completely identified by attaching phenolic nameplates with lettering, etc 1 " in height.

D. This contractor shall be responsible for the number, location and size of all necessary openings in the building walls for the entrance of service conduits and other conduits into the building.

3.7 INSPECTION

A. Contractor shall examine location where electric service equipment and raceways are to be installed, determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.8 INSTALLATION

A. Install equipment and components where shown or as directed, in accordance with manufacturer's written instructions, Utility Company's instructions (where applicable), and with recognized industry practices, to ensure that installation complies with requirements and serves intended purposes.

B. Coordinate with other work as necessary to coordinate installation of equipment with other components of systems.

END OF SECTION

SECTION 26 05 13

MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this section:

1. Electrical Requirements.

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power, distribution on related systems rated over 600 volts.
B. Medium voltage cables must meet Central Hudson Utility requirements.

C. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 2 Section “Earthwork” for trenching and backfilling.
2. Division 26 Section “Electrical Boxes and Fittings” for connectors for terminating cables in boxes and other electrical enclosures.

1.3 SUBMITTALS

A. Cables 15KV Rated:

1. Submit manufacturer’s product data, for the review and approval on medium voltage cables including, but not limited to, the following:
   a. Acceptance by Central Hudson Utility with Pictorial diagram showing construction of cable.
   b. Written indication that cable meets or exceeds the specification and any exceptions taken to the specification.

B. Joints and Splices:

1. Submit manufacturer’s product data and Central Hudson Utility requirements for the review and approval on cable joints and splice including, but not limited to the following:
   a. Material and construction of joint.
   b. Manufacturer’s written instruction for installation of joint.

C. Terminations:

1. Submit manufacturer’s product data for review of 15KV cable terminations including, but not limited to the following:
   a. Material and construction of termination.
   b. Manufacturer’s written instructions for installation of termination.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following code:

B. NFPA 70 “National Electrical Code.

1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
2. Meets Central Hudson Utility requirements.

C. UL Compliance: Provide components which are listed and labeled by UL under the following standards.

1. UL Std. 44: Rubber Insulated Wires and Cables.
2. UL Std. 83: Thermoplastic-Insulated Wires and Cables.
3. UL Std. 486A: Wire Connectors and Soldering Lugs for Use with Copper conductors.
4. UL Std. 854 Service Entrance Cable.

D. NEMA/ICEA Compliance: Provide components which comply with the following standards:

1. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. WC-7: Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. WC-8: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
4. AEIC CS-6: Associated Edison Illuminating Co. - EPR insulated power cable 1.5 - 69KV (10/87).

E. IEEE Compliance: Provide components which comply with the following standard.

1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated conductors.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLES

A. Provide single conductor 15KV shielded power cable insulated with ethylene propylene rubber (EPR) rated for 133% insulation level. The cable shall have a continuous temperature rating of 90°C, an emergency overload temperature rating of 130°C, and a short-circuit temperature rating of 250°C. The cable shall be suitable for operation in wet or dry locations and for installation in duct or conduit. The cable shall be listed as Type MV-90 and shall carry a UL label.

B. Insulation shield shall be semi-conducting extruded, semi-conducting EPR, and uncoated copper tape. Shield ampacity shall be equivalent to one overlapped 5 mil copper tape (with a 12.5% (mini-overlap)). Jacket thickness shall not be less than 80 mils, of black polyvinyl chlorides. The cable must be triple tandem extruded and all ethylene propylene system. The insulation, inner screen, and outer screen shall all be EPR. The insulation should not contain any polythlene. The cable must be flat line corona tested with less than 5 picocoulombs. Cable shall meet the requirements of AEIC CS6, ICEA S-68-516, and UL1072.

C. Separable insulated connectors shall conform to IEEE Standard 386 “Separable Insulated Connectors for Power Distribution Systems Above 600V.”

D. Termination shall be Class 1 or Class 2; of the molded elastomer, wet-process porcelain, pre-stretched elastomer, heat shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant, silicon-rubber, or tract-resistant ethylene-propylene compounds. Indoor Class 2 terminations shall be used except where termination is exposed to outdoor environment, then Class 1 terminations shall be used. Class 3 terminations are not acceptable.

E. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Connectors shall be of suitable construction for the application and type of cable connected, and shall include cable shield adapters.

PART 3 - EXECUTION

3.1 WIRE

A. Install all above grade medium voltage cable in rigid metallic conduit on line and load side of main service switchgear unless noted otherwise.

B. A wire pulling lubricant must be used when pulling conductors through conduit or duct runs over 10 feet in length. The pulling compound shall be compatible with the raceway, conductor and jacket material.

C. Cable splices and joints shall be allowed only in pull boxes.

D. Ground conductors shall be installed in the same duct with their associated phase conductors.

E. Wires shall be pulled in using pulling eyes securely attached to the conductor. Pulling grips which transmit the pulling tension directly to the jacket or insulation shall not be permitted.

3.2 JOINTS AND SPLICES

A. Joints and splices shall be performed based on the manufacturers' written instructions.

B. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shield may be integrally molded parts of preformed joints. Shields shall be grounded at each joint.

3.3 TERMINATIONS

A. Terminations shall be of the type required for equipment termination, and shall be performed based on the manufacturer's written instructions.

B. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding.

3.4 TESTING

A. Products.

1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the tests described in this Section.

3.5 EXECUTION

A. Insulation Resistance (Megger) Testing

1. This procedure will provide the necessary guidelines to ensure an acceptable insulation resistance test.
   a. This procedure is applicable to Megger testing only.
   b. Megger testing shall be done during both construction and start-up.
   c. This procedure applies to the following equipment:
      1) Medium Voltage Cable.

2. In all cases, the manufacturer's instructions shall be consulted and integrated into this test guideline to assure full compliance and acceptance without jeopardizing equipment warranties.
3. Test Preparation:
   a. Verify that proper Megger apparatus of the correct voltage is available.
   b. Equipment to be tested shall be clean and dry.
   c. All equipment shall be tested before being initially energized. All necessary precautions shall be taken to prevent the equipment from becoming energized during the test.
   d. Except as required for testing, all construction related to the equipment shall be finished.
   e. Ensure equipment frame grounds are complete.
4. Test Procedure:
   a. Voltage shall be applied.
   b. After each test, the equipment shall be adequately grounded to remove any residual charge.
   c. Equipment shall be tested both phase to phase and phase to ground where applicable.
   d. Medium voltage 15KV cables shall be tested twice.
      1) After pulling but before termination, all cables shall be tested just prior to termination to determine if any damage occurred during pulling.
      2) After termination, medium voltage cables shall be tested just prior to being energized, as part of the system including the intended load.
5. Test Acceptance:
   a. The tests shall be considered satisfactory on the equipment being tested if all recorded readings meet the manufacturers' acceptance criteria.

3.6 DIRECT CURRENT OVERPOTENTIAL TEST

A. This test procedure will provide the necessary guidelines to accomplish an acceptable insulation overpotential test.

1. This procedure is applicable to cable rated for 15KV.
2. This test is to be performed after equipment or cable installation but prior to initial operation.

B. In all cases the manufacturer's instructions shall be consulted and integrated into this procedure to assure compliance and acceptance without jeopardizing equipment warranties.

C. Preparation:

1. Take necessary steps to insure that equipment will not become energized during the test.
2. Appropriate D.C. hi-pot equipment is available and the user is familiar with its operations.
3. The equipment to be tested has successfully passed an insulation resistance test (Megger) immediately prior to this test.
4. The equipment to be tested is isolated from all associated equipment (motors, transformers, potential transformers, etc.).
5. The equipment must be clean and dry.
6. Cables should be terminated, installed but not connected to equipment.
7. Signs have been posted at all necessary locations warning "High Voltage Tests in Progress."
8. Appropriate grounding devices are available.

D. Test Procedure:

1. Single conductors are to be tested from conductor to ground with the shield adequately grounded.
2. Three phase conductors are to be tested individually to ground with the shield and other two phases adequately grounded.
3. Ensure that equipment is de-energized and necessary measures are taken to prevent it from becoming energized during the test.
4. Ensure that equipment is isolated from all associated equipment.
5. Ensure all appropriate safety precautions have been followed.

6. Determine test voltage and test duration from TABLE 1 in this section.
7. For cables, to limit the maximum voltage stress on the insulation at the conductor to a safe value, the minimum size of the conductor shall be in accordance with the tables.
8. Set up the D.C. hi-pot apparatus following the manufacturer's instructions. A non-fluctuating power source may be required. If required the regulated power source shall be provided by the Contractor.
9. Apply the initial voltage and read the microampere leakage as quickly as possible and record the data. Do not wait for the reading to stabilize.
10. Quickly raise the voltage in 5KV increments stopping only long enough to obtain a microampere reading, until the test voltage is obtained.
11. Take microampere leakage readings at the rated test voltage at intervals of 15 sec., 30 sec., 45 sec., 1 min. and every 1 minute thereafter for the duration of the test (15 minutes). Record the readings.
12. After the test is complete, the conductor shall be grounded for a period not less than 4 times the charging time to remove any residual charge.

E. Test Acceptance:

1. The leakage current will generally start off at a relatively high value and drop off rapidly, becoming constant at some low value. The fact that the current levels off and becomes constant is more important than the actual value of the leakage current.
2. If the current does not drop down or after dropping starts to rise again, this is a strong indication of trouble in the circuit.
3. Leakage values are generally not compared to leakage rates from other similar conductors or even the same conductor tested at another time. Temperature and moisture have a considerable influence so that values are not usually representative of the actual insulation value of the equipment.
4. Results of the test shall be documented and submitted to the Engineer for approval. Submittal shall also include cable length, cable identification, cable size, temperature and humidity in which the test was performed.

3.7 REFERENCES

A. AEIC CS6-79 Specification for Ethylene Propylene Rubber Insulated shielded Power Cables Rated 5 through 69KV.

TABLE 1

Rated Voltage Phase to Phase KV	Conductor AWG or KCMIL	Insulation Thickness MILS		After Insulation 15 minute DC test Voltages KV	
		A	B	A	B
15	2 to 1000	125	115	25	25

NOTES:

(1) After installation test values are based on 80% of AEIC factory test values.
(2) Cables having the same voltage rating may have different insulation thicknesses. The test voltage applied should correspond to the thickness. Column A refers to 100% insulation level whereas Column B refers to 133% insulation level.

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirement of the following Division 26 Sections apply to this section:

1. Electrical Requirements

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.

B. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 2 Section “Earthwork” for trenching and backfilling.
2. Division 26 Section “Electrical Boxes and Fittings” for connectors for terminating cables in boxes and other electrical enclosures.

C. The work includes providing wire and cable complete with all accessories in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted. For special wiring for individual systems refer to respective Section of these Specifications.

1.3 SUBMITTALS

A. Product Data for electrical wires, cables and connectors.

B. Shop drawings shall include detail drawings and data sheets for all wire and cable, compression wire connectors, large aluminum wire connectors, and large copper wire connectors.

C. Cable Pulling Submittals:

1. The following requirements pertain to all 600 volt or less feeders, sized 4/0 AWG or larger that are either in excess of 200 feet or requiring more than 180° of bend:
2. The Contractor shall utilize a pulling calculation software package, such as Polywater Cable Management Software or SKM Cable Pulling Analysis Software, to model and determine the expected pulling tensions and sidewall pressures that the conductor(s) will be exposed to. If the calculations determine that the expected pulling tensions and sidewall pressures will exceed the manufacturer's recommended values, the contractor is responsible making modifications necessary to correct the problem and re-run the analysis. Contractor shall submit the results of the analysis for the intended conduit routing prior to commencement of cable pulling for engineer’s approval. If the intended conduit routing is modified due to engineers comments or coordination with the other trades the contractor must re-run the analysis and resubmit for approval.
3. Contractor to submit detail conduit routing drawings showing pulling set ups and direction of cable pulls. These drawings shall clearly detail the intent of the cable pulls with reference to cable pull models. Indicate all splice locations for approval by engineer and owner.

4. Submit wire manufacture's maximum pulling tension and sidewall pressure recommendation.
5. Submit cable pulling machine for approval.
6. Submit UL listed pulling lubricants for approval.
7. Utilize Tensiometer similar or equal to, Condux Running Line Tensiometer, CableGlider HD.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following code:

B. NFPA 70 "National Electrical Code."

1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
2. Comply with most restrictive code.

C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.

1.	UL Std. 44	Rubber Insulated Wires and Cables
2.	UL Std. 83	Thermoplastic-Insulated Wires and Cables
3.	UL Std. 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
4.	UL Std. 854	Service Entrance Cable

D. NEMA/ICEA Compliance: Provide components which comply with ANSI/NEMA WC 70-2009 / ICEA S-95-658-2009.

E. IEEE Compliance: Provide components, which comply with the following standard.

1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

F. QUALITY ASSURANCE

1. "Manufacturers" - Firms regularly engaged in manufacture of wire and cable of types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
2. Provide wire and cable which has been listed and labeled by Underwriters' Laboratories, and comply with applicable portions of National Electrical Manufacturers Association Standards.
3. Provide wire and cable produced by a manufacturer listed as an Approved Manufacturer in this section.
4. Provide equipment whose performance under specified conditions, is certified by the Manufacturer.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600 VOLT COPPER CONDUCTORS)

A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.

B. All wires and cables shall be of the same manufacturer throughout the entire project.

C. Conductors:

1. Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
2. Minimum conductor size shall be No. 12 for lighting and power and No. 14 for control and alarm. Increase wire as noted hereinafter for long runs.

3. Communications and signal wiring shall conform to the recommendations of the manufacturer's communication and signal systems and shall be as specified in respective Sections of these Specifications.

D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600 volts, which conform to or exceed ICEA specifications. Use XHHW-2 or THWN-2/THHN, UNO.

1. Emergency system feeders shall either be a listed 2-hour cable paired with listed conduit, MI cable, or encased in minimum of 2 inches of concrete.

E. Grounding conductors: Shall be of the same type as its associated phase conductors.

F. All conductors shall be label with wire size, insulation rating, etc using an engraved process. Computer scan or labels are not permitted.

G. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.

1. Where color-coded cable is not available, certify in writing and request permission for overlap color taping conductors (minimum length 6 in.) in accessible locations.
2. Conductors for control circuits and signal systems shall also be consistently color coded to avoid confusion and permit easy identification of conductors. The IPCEA color code shall be used wherever possible. No two wires in the same raceway shall be the same color, unless provided with flameproof linen identification tags on each end.

H. Connectors for Conductors:

1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.
3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

I. Splices and Taps:

1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.

J. Wire Sizes

1. For General Use:
   a. No. 12 minimum copper wire shall be used for lighting and power.
   b. No. 10 minimum copper wire shall be used at 120 volts and over 90 ft. for 15 amp circuit and 60 ft. for 20 amp circuit length.
   c. No. 10 minimum copper wire shall be used at 265 volts and over 175 ft. circuit length.
2. For Control and Alarm (unless otherwise noted):
   a. No. 14 minimum copper wire shall be used.
   b. No. 12 minimum copper wire shall be used at 120 volts and over 60 ft. circuit length.

3. For Other Voltages and Phases and for Longer Circuit Lengths: Size wire as required to maintain equivalent voltage drop.

4. Raceways: Increase raceway sizes for larger wire as required.

K. Insulation:

1. Rubber and thermoplastic insulation shall comply with ASTM and IPCEA standards. Paper and lead insulation shall comply with AEIC standards

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Use the following wiring methods as indicated:

1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires, and connectors in compliance with NEC.

B. Coordinate cable and wire installation with other Work.

C. Wire and cable shall not be drawn into conduit and raceways until all conduit work is complete - joints made up tightly and the entire run secured in place.

D. Do not install more conductors in a raceway than indicated on the drawings. A maximum of six branch circuits are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three branch circuits are installed in a raceway, the conductor size shall be increase per code for derating.

E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.

F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in ¾" conduit, protected by 20 amperes circuit breakers.

G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310-16 of the latest National Electric Code for the load served.

H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

I. Care shall be exercised in pulling to avoid damage to the wire or cable. Lubricants shall be used for pulling wire or cable if the character of the pull would otherwise damage the conductors, insulation or jacket. Pull no thermoplastic wires at temperatures lower than 0□C.

J. Use pulling means including: fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

K. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest National Electrical Code.

L. Keep conductor splice to minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code. Do not splice conductors in panelboards, safety

switches, switchboards, or motor control enclosures. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect.

M. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation than conductors being spliced.

N. Use splice and tap connectors which are compatible with conductor material.

O. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

P. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B.

Q. 600 Volt Wire and Cable:

1. The inside of conduits and raceways shall be dry and clean before wires are pulled.
2. Cables shall be supported at the upper end of all risers and at intermediate points as required by the NEC. Supports shall be O.Z. Type "R" or approved equal, insulation wedges or Kellems grips.
3. Wire and cable shall be installed in accordance with manufacturer's instructions.
4. Seal, between the wire and conduit with a non hardening compound approved for the purpose, all cable and wire entering a building from underground where cable exits the conduit.
5. Cable spacers shall be installed where required. Spacers shall be conduit fittings for spacing of cables at terminations and shall consist of galvanized or cadmium plates, steel or malleable iron threaded conduit and fittings and inserts of non-metallic insulating material with openings adequate to accommodate cables being spaced. Cable spacers shall be adequate to accommodate cables being spaced. Cable spacers shall be O.Z. Mfg. Co., Inc. Type E or Type EL with grounding lug or approved equal.
6. Provide separate raceways for conductors of 120/208 and 277/480 volt systems.
7. Install cable limiters at each end of each conductor of more than three (3) paralleled conductors per phase, over 100 ft. in length. Limiters shall be rated 600 volts, 200,000 amps RMS interrupting capacity and shall have waterproof sleeves.
8. Direct burial cables shall be covered with a 1 in. thick by 8 in. wide white-pine board pressure-treated with a non-creasote-type wood preservative, placed over 3 in. layer of clean, well-tamped sand.
9. Under all paving and at crossover of all other utilities, underground cables shall be installed in PVC conduit and encased in concrete.
10. Thermoplastic wires shall not be installed in computer area raised floors.
11. Provide individual raceways for two pole ungrounded circuits.
12. In certain systems, equipment furnished by an approved manufacturer may require a different number and arrangement of conductors from that indicated on the Drawings. In such cases, the Contractor for the work under this Division shall comply with such requirements at no additional cost to the Owner.
13. In the event the Contractor for the work under this Division or Section chooses to furnish and install a system or item of equipment of different arrangement from that shown or specified, he shall furnish and install any additional wiring and conduit required by the system at no additional cost to the Owner.
14. In wireways and large pull boxes, lace and tie off conductors in groups of 3 phases and neutral (if used) to limit conductor unbalanced loading. Conductor group shall be as installed in conduits.
15. Tag all feeders and risers in all pull boxes and in all gutter spaces through which they pass. Tags shall be engraved white core nameplates identifying feeders as shown on the Drawings or the circuit protective device from which they originate.
16. Leave all wires with enough slack at terminals ends for convenient connections and fixtures and for convenient servicing. Stow loose ends neatly in outlet box.
17. Splices and taps shall be made in accessible boxes, panelboards fittings, gutters, terminal panels, etc. only. Materials shall be compatible with the conductors, insulations and protective jackets on the cables and wires.

18. All copper conductors No. 8 & larger shall be spliced, and tapped with color-keyed compression connectors, as manufactured by Thomas & Betts Co., Series 54000, Ideal Industries Series 87000, or approved equal. The manufacturers recommended tooling shall be used. Mechanical type connectors shall not be used. All copper conductors No. 8 and larger shall be terminated with self crimping, self adjusting, spring action type cable terminators, as manufactured by CYTOLOK or approved.
19. All copper conductors No. 10 AWG & smaller shall be terminated and spliced with Ideal Industries wing-nut wire connectors, or approved equal compression connectors. The nylon self-insulated type shall be used to isolate the terminal from other metal parts and equipment.
20. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined.
21. Plastic electrical insulating tape shall be flame retardant, cold and weather resistant.
22. All circuit and control wiring in cabinets, panels, pullboxes, and junction boxes shall be tied and held with nylon Ty-Rap cable ties as manufactured by Thomas & Betts Co. or approved equal.
23. Wire identification ties fastened to conductors at the point of attachment to terminal blocks and equipment components shall be nylon, self-locking Ty-Raps as manufactured by Thomas & Betts Co., Series Ty-51M, 53M, or approved equal.
24. Cables shall be tagged in all pull boxes, wireways and wiring gutters of panels. Where two or more circuits run to or through a control device, outlet box or junction box, each circuit shall be tagged as a guide in making connections.
25. Tags for feeders shall indicate feeder number, size, phase, voltage, origin and termination. Feeder tags shall identify all phases individually.
26. Tags for control and alarm wiring shall indicate type of control or alarm, size of wire and origin and termination.
27. Tags shall be Thomas Betts Co., Ideal Industries wire-marker dispenser type, self-laminated wire markers.
28. Wire lubricating compound shall be suitable for the wire insulation and conduit with which it is used, and shall not harden or become adhesive. Lubricating compound shall be Ideal Industries, Type Yellow 77, or approved equal. Lubricating compound shall not be used on wire for isolated type electrical power systems.
29. Contractor shall examine the areas and conditions under which wire and cable are to be installed, and notify Architect in wiring of conditions detrimental to proper and timely completion of the work.
30. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 FIELD QUALITY CONTROL

A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.

E. TABLE 1: Color Coding for Phase Identification:
1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

208V/120 Volts	Phase	480V/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green		Ground Green

3.4 FEEDER TESTING

A. Products

1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.

B. Execution

1. Visual and Mechanical Inspection
   a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
   b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
   c. Check cable color coding with Table I in this section and National Electrical Code standards.
2. Electrical Tests
   a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
   b. Perform continuity test to insure proper cable connection.
   c. Megger conductors phase-to-phase and phase-to-ground for continuity and insulation tests before connection to utilization devices for the following:

      1. 100 percent of feeders.
      2. 10 percent of branch circuits.
      3. 100 percent of 3-phase motor branch circuits.

   d. Verify phase rotation for all three-phase motor circuits.
3. Test Values
   a. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
   b. Submit results to Engineer for approval in accordance with Section 26 05 02 and 26 05 03.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work of this section.

C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this section includes the following:

1. Solidly grounded.

C. Applications of electrical grounding and bonding work in this section includes the following:

1. Underground metal piping.
2. Underground metal water piping.
3. Underground metal structures.
4. Building frames - structural steel.
5. Electrical power systems.
6. Grounding electrodes.
7. Separately derived systems.
8. Raceways.
9. Service equipment.
10. Enclosures.
11. Equipment.
12. Lighting Standards.
13. Landscape Lighting.
14. Signs.
15. Lightning Protection System

D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s data on grounding and bonding products and associated accessories.

B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.

D. Shop drawings shall include splice kits, ground rods, and ground wire.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
4. For patient care area electrical power systems, grounding shall conform to Article 517 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and Components:

1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/3 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 5 AWG, stranded conductors.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

D. Grounding Bus: Rectangular bars of annealed copper (1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper clad steel; not less than 3/4 inch by10 feet (19 mm by 3 m) in diameter.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturer's recommended material.

C. Ground clamps shall be bronze, solderless type with bronze screws suitable for receiving required or noted conductors.
D. Grounding wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the Drawings, or specified.

PART 3 – EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned copper conductor, No.3/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No.3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal in addition to the equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 EXAMINATION

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.5 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

E. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
3. Where required to obtain the specified ground resistance, install multiple rods.
4. Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

F. Test Wells: Ground rod driven through drilled hole in bottom of manholes. Manholes are specified in Division 26 Section "Underground Services and Manholes," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Grounding and Bonding for Piping:

Bond the water piping to the building ground with approved grounding clamps. All ground connections shall be executed with the same thorough workmanship as the connections for normal current carrying parts. The work must be neatly installed, as careless grounding either in appearance or workmanship will be rejected.

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment each unit substation, or each main electrical room grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No.4/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building foundation.

L. Under Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6m) of bare copper conductor not smaller than No. 4/0 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

M. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

N. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

O. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

P. The complete electrical installation shall be permanently and effectively grounded before the water meter and grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified. Measured resistance to ground shall be 5 ohms. maximum.

Q. Parts of the electrical installation to be grounded shall include, but not be limited to, the following: underground distribution, outdoor substation service equipment, electrical service system neutral, conduit system for light and power, switchgear housings, cabinets, housings and neutrals of transformers, motor frames, housings of alarm and control panels and associated devices, lighting fixtures, lightning protection system, emergency distribution system, telephone system, fire alarm system, smoke detection system, communications and security system, busway enclosures, motor control centers, individual starters and other non-current carrying metal parts of electrical equipment.

R. All copper bars for grounding shall be medium hard drawn. After installation, the copper bar shall be painted with one coat of an approved lacquer.

S. Ground conductors shall be of sizes and material in accordance with the requirements of the National Electrical Code. Cable for grounding connections shall be bare in accordance with the latest revisions of ASTM Designations B3 and B8. All open bare grounding cable shall be secured in place with cast and honed malleable clamps and clamp backs, and 1/4 inch bolts.

T. Ground wires shall be continuous without splices. There shall be no soldered joints in any ground connection. Connectors, clamps, etc. shall be solderless type.

U. Ground outdoor electrical equipment to driven ground rods, as required by code.

V. Ground interrupted metallic raceways with ground conductors connected to metallic raceway at each end.

W. Separately ground center taps of wye connected transformers in accordance with National Electrical Code (NFPA 70).

X. Where ground connections will be permanently concealed, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connections.

Y. Service at power company interface points shall comply with the power company ground resistance requirements.

Z. Connect all sections, poles and doors of outdoor fences to the grounding electrode system.

AA. Connect lightning arrestor grounds to the equipment ground bus, or ground rods as applicable.

BB. For duct banks and manholes provide a bare equipment grounding conductor in each duct bank containing medium or high voltage cables. Connect the grounding conductor to the switchgear ground bus, to all the manhole hardware, to the cable shielding of medium or high voltage cable splices and terminations, and equipment enclosures.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

B. Inspect all connections prior to concealing same.

PART 4 – APPROVED MANUFACTURERS

A. For ground rods.

1. Carolina Galvanizing.
2. Weaver Electric

END OF SECTION

SECTION 26 05 29

SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this section:

1. "Electrical Requirements."

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related Sections: The following Sections contain requirements that related to this Section:

1. Division 3 Section "Mild Steel Concrete Reinforcement" for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
2. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
3. Division 7 Section "Firestopping" for requirements for firestopping at sleeves through walls and floors that are fire barriers.
4. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

C. Shop drawings indicating details of fabricated products and materials.

D. Engineered Design consisting of details and engineering analysis for supports for the following items:

1. Cable Tray.
2. Conduit (racked)
3. Ceiling mounted boxes, transformers.
4. Conduit - Ceiling mounted, concrete encased.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with local codes as well as NFPA 70 “National Electrical Code.”

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

C. Installation shall comply with local authorities’ seismic requirements.

PART 2 - PRODUCTS

2.1 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: 16-guage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with local codes and NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with local codes, the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceway in accordance with NEC.
7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples of threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Stopping" requirement of Division 7.

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.
2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

NOTES:

1. Maximum spacing of supports (feet).
2. Maximum spacing for IMC applies to straight runs only. Otherwise the maximum of EMT applies.
3. Support for cable tray shall be as directed in their respective sections.

END OF SECTION

SECTION 26 05 33

RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Electrical Requirements."

1.2 SUMMARY

A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:

1. Rigid metallic conduit (RMC).
2. Intermediate metal conduit (IMC).
3. Electrical metallic tubing (EMT).
4. Flexible metal conduit (FMC).
5. Liquid-tight flexible conduit (LFMC).
6. Rigid aluminum (RA).
7. Metal clad cable (MC).
8. Rigid non-metallic conduit (PVC).
9. Wireway (WW).
10. Surface metal raceways (SMR).

B. Related Sections: The following section contains requirements that relate to this section:

1. Division 26 Section "Electrical Boxes and Fittings" for conduit connectors, fittings, and couplings.
2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.
3. Division 28 Section "Fire Alarm".

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.

B. Product Data for the following products:

1. Raceways and fittings.
2. Wireways and fittings.
3. Boxes and fittings.
4. Color selection chart for wall plates.

C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”

B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.

D. Manufacturers - Firm regularly engaged in manufacture of raceways of types and capacities required and whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1

1. Shall be full weight steel pipe, hot dip galvanized inside and outside, threaded, minimum 3/4 inch.
2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.

B. Intermediate Steel Conduit: UL 1242.

1. Shall be intermediate weight steel pipe, hot dip galvanized, threaded, minimum 3/4 inch.
2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.

C. Electrical Metallic Tubing and Fittings: ANSI C80.3.

1. Shall be thin wall steel pipe, galvanized, thread-less, minimum 3/4 inch. EMT shall not be used for cable rated above 600 volts.

D. Flexible Metal Conduit: UL 1, zinc-coated steel.

1. Shall be continuous single strip, galvanized, minimum 3/4 inch.

E. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.

1. Liquid-tight, flexible steel, conduits shall be zinc coated flexible galvanized steel tubing over which is extruded a liquid- tight jacket of polyvinyl chloride (PVC). Conduit shall be provided with a continuous copper bonding conductor wound spirally between the convolutions.

F. Rigid Aluminum Conduit:

1. Rigid aluminum conduit shall be full weight pipe, threaded, minimum ¾ inch.

2.2 METAL CLAD CABLE, TYPE MC

A. The multi-conductor metal clad cable shall comply with UL 1569 “Metal Clad, Type MC,” UL 83 “Thermoplastic Insulated Wires and Cables” Federal Specification J-C-30B “Wire and Cable,” Local and National Electrical Codes.

B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.

C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both concealed, and very limited exposed work, in accordance with applicable sections of the National Electrical Code.

D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.

E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. A PVC jacket shall completely cover the steel or aluminum armor where liquid tight flexible metal conduit is required.

2.3 NONMETALLIC CONDUIT AND DUCTS

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.

B. PVC Conduit Fittings: NEMA TC 3; match to conduit type and material.

1. Shall be self-extinguishing, UL listed.
2. Located in building interiors and direct burial, shall be heavy wall, Schedule 40.

C. Conduit and Duct Accessories: Types, sizes and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

2.4 CONDUIT BODIES AND FITTINGS

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.

1. Metallic conduit fittings shall be corrosion resistant.

C. EMT Conduit Bodies: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.

1. Material shall be steel or malleable iron only.
2. Couplings and connectors shall be "concrete tight" or "raintight", couplings and connectors for conduit sizes 2-inch and smaller shall be of the gland and ring compression type. Connectors shall have insulated throats.
3. Set screw or indent type connectors are not permitted. Compression waterproof connection type fittings only shall be utilized.

D. Nonmetallic Conduit: Use nonmetallic conduit bodies conforming to UL514B.

E. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, a steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.

F. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC – and EMT, larger than ¾" size.

1. Bushings shall be of the metallic insulated type.

G. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two piece barrel and piston joint, providing 6" of the total movement range in ¾" through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in ¾" to 2" conduit sizes.

1. Shall comply with UL 467 and UL 514 and shall accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and shall allow 30 degree angular deflections.
2. Shall include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC tables for ground conductors.
3. Shall be watertight, seismically qualified, corrosion- resistant, threaded for and compatible with rigid or intermediate metal conduit.
4. Jacket shall be flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

H. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

I. For weatherproof and dust-tight installations provide liquid-tight fittings with sealing ring and insulated throat.

J. Rigid steel and IMC conduit fittings:

1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be steel or malleable iron only.
2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
3. Bushings shall be of the metallic insulating type, and shall consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type. In concealed work, each fitting shall be installed in a flush steel box with blank coverplate having the same finish as that of other electrical plates in the room.

K. Rigid aluminum conduit fittings:

1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper.
2. Locknuts and bushings shall be as specified for rigid steel and IMC conduit.
3. Set screw fittings shall not be used with aluminum conduit.

L. Direct burial plastic conduit fittings shall be as recommended by the conduit manufacturer.

M. Surface metal raceway fittings shall be as recommended by the raceway manufacturer

N. Flexible steel conduit (Greenfield) fittings:

1. Material shall be steel or malleable iron only.
2. Shall be multiple point type, threading into the wall of the conduit convolutions, and shall have insulated throat.

2.5 WIREWAYS

A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC. Wireways shall be steel and of sizes noted and shall have a minimum of No. 16 gauge thickness.

B. Wireway covers shall be hinged type.

2.6 SURFACE METAL RACEWAYS

A. General: Sizes and channels as indicated. Provide fittings that match and mate with raceway. Provide internal barriers for areas with power and communications sections. Shall be steel with baked enamel finish, of sizes noted, and a minimum of No. 20 gauge thickness.

B. Surface Metal Raceway: Construct of two piece galvanized steel with snap-on covers, with 9/32-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required. Sizes 1-3/4" H x 4-3/4" W.

C. Provide labeling for each outlet with panel and circuit number where multi-outlet raceways are utilized.

D. Accessories:

1. Couplings for joining raceway sections.
2. Wire clips for conductors.
3. Blank end fittings.
4. Circuit breaker housings for single pole breakers.
5. Device brackets for single or two gang devices.
6. Combination receptacle and telephone outlet covers.
7. Outlet boxes with hubs for conduit connectors.

E. Covers for the surface metal raceways shall be snap-on type, unless otherwise noted.

2.7 CONDUIT SUPPORTS:

A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.

B. Individual conduit hangers shall be designed for the purpose, with pre-assembled closure bolt and nut, and provisions for receiving hanger rod.

C. Multiple conduit (trapeze) hangers shall be of not less than 1-1/2 by 1-1/2 inch, 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8-inch diameter steel.

D. Solid masonry and concrete anchors shall be a type approved for the purpose.

2.8 SLEEVES

A. Provide and assume responsibility for locating and maintaining in proper position all sleeves required for the work.

B. For raceways in sleeves, provide seals of oakum packing and lead or O.Z. Type WSK series compound on both sides.

C. For cables through sleeves, provide seals similar to O.Z. Type WSCS compound.

D. Through floors, exterior masonry walls, roof, and underground, sleeves shall be schedule 40 galvanized steel pipe. For area not requiring schedule 40 pipe, sleeves shall be 18 gauge galvanized steel pipe.

2.9 CONCRETE MARKERS

A. Provide over all underground raceway bends and terminations, cylindrical concrete columns markers. The markers shall be 5 in. diameter and 18 in. deep and shall have imbedded marked bronze plate noting the direction of the raceway.

2.10 FIRE SEALANTS

A. Openings through floors and walls in which cables, conduits, or pipe pass shall be sealed by U.L. classified smoke and fire stop fittings, and have an hourly rating equal to the fire rating of the floor or wall. Fittings shall be similar to O-Z Gedney Type "CES" or "CAFS".

B. Penetrations through fire-rated floors in which wiring for floor service outlets are routed shall be sealed by U.L. classified smoke and fire-stop fittings, and shall have an hourly rating equal to the floor rating. Fittings shall be similar to O-Z Gedney Type "PTFS".

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Use the following wiring methods:

USES	TYPE Rigid Metallic Conduit (RMC)	TYPE Interm. Metal Conduit (IMC)	TYPE Elec Metal Tubing (EMT)	TYPE Flex metal Conduit (FMC)	TYPE Liquid Tight Flex Metal Conduit (LFMC)	TYPE Rigid Alum. (RA)	TYPE Metal Clad Cable (MC)	TYPE Rigid Non Metal (PVC)	TYPE Wire-Way (WW)	TYPE Surface Metal Raceways (SMR)
Outdoor underground concrete encased, below building or away from building	X							X		
Outdoor above ground exposed or concealed	X	X								
Outdoor above ground final connection to vibrating equip: xfrms, solenoids, motors, etc.					X					
Indoor 600 volts and above concrete encased.	X									
Indoor exposed 10 feet to floor in “back of house”	X	X								

USES	TYPE Rigid Metallic Conduit (RMC)	TYPE Interm. Metal Conduit (IMC)	TYPE Elec Metal Tubing (EMT)	TYPE Flex metal Conduit (FMC)	TYPE Liquid Tight Flex Metal Conduit (LFMC)	TYPE Rigid Alum. (RA)	TYPE Metal Clad Cable (MC)	TYPE Rigid Non Metal (PVC)	TYPE Wire-Way (WW)	TYPE Surface Metal Raceways (SMR)
spaces such as mechanical, electrical, basements, attics, etc.										
Indoor exposed above 10 feet to floor.			X			X				
Indoor concealed homerun to panelboards, and for branch circuits			X							
Indoor concealed final branch wiring to receptacles and light fixture. Max 50' length from homerun j-box to outlet. MC not allowed for isolated ground circuits, or homeruns to panels, or connections to mechanical equipment. Max conductor is #8 AWG MC Cable.							X			
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc. in dry areas				X						
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc., in moist, humid, wet, or corrosive areas.					X					

USES	TYPE Rigid Metallic Conduit (RMC)	TYPE Interm. Metal Conduit (IMC)	TYPE Elec Metal Tubing (EMT)	TYPE Flex metal Conduit (FMC)	TYPE Liquid Tight Flex Metal Conduit (LFMC)	TYPE Rigid Alum. (RA)	TYPE Metal Clad Cable (MC)	TYPE Rigid Non Metal (PVC)	TYPE Wire-Way (WW)	TYPE Surface Metal Raceways (SMR)
Within concrete slabs, or connections to cast-in-place floor boxes. LFMC not allowed for homerun. Maximum sizes and locations of conduit subject to approval by structural engineer and Architect	X	X			X					
Hazardous Areas	X									
Terrazzo floor with conduit routed underneath, not within terrazzo.	X									
Fire Alarm initiating circuits and signaling circuits.			X							
Fire alarm system auto dialer telephone circuit	X									

3.2 INSTALLATION

A. General: Install electrical raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, and as follows.

B. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

D. Complete installation of electrical raceways before starting installation of conductors within raceways.

E. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities' seismic requirements.

F. Prevent foreign matter from entering raceways by using temporary closure protection.

G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.

H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.

J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

K. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.

L. All exposed conduits in public areas shall first be approved to be routed in public areas, then be painted to match surrounding walls. Verify exact color with the Architect.

M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.

N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.

O. Tighten set screws of threadless fittings with suitable tool.

P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with concave side against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.

Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.

S. Telephone and Signal System Raceways: In addition to the above requirements, raceways 2-inches and smaller, shall have a maximum length of 150 feet with a maximum of two 90° bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

T. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install

raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
2. Where required by the NEC.

U. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

V. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement. Install separate equipment grounding conductor across flexible connections.

W. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

X. All underground conduits shall be installed a minimum of 48 inches below finish grade for primary medium voltage feeders and 30 inches for 480 volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.

Y. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.

3.3 RACEWAYS

A. Install conduit and tubing products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with the recognized industry practices to ensure that products serve intended function.

B. Run raceways concealed, except as noted. Exposed raceways shall be run parallel with or at right angles to walls.

C. Raceways supports shall be provided by means of ceiling trapeze, strap hangers, or wall brackets, structural steel angles or channels. Provide U-bolts at each floor level or riser raceways and connected to acceptable supports. Secure raceways to supports with pipe straps or U-bolts. Spacing of support shall be as per NEC and per manufacturer's recommendations.

D. Mount supports to structure with toggle bolts on hollow masonry, expansion shields or inserts on concrete and brick, machine screws on metal, wood screws on wood. Nails, rawl plugs or wood plugs are not permitted.

E. Provide a 12 in. minimum separation between raceways and steam and hot water pipes. Provide approved thermal insulation for electric lines where this separation cannot be maintained.

F. Keep raceways clear of motor foundations and from underside of boilers. Also, install raceway so that they will not obstruct headroom, doorways, or walkways.

G. For outlets located in hung ceilings, run raceways in hung ceilings and support from structure above. For lay-in ceilings, install conduits high enough to permit removal of ceiling tiles.

H. In walls, run raceways vertically only.

I. Mechanically join all metal raceways, enclosures and junction boxes to form a continuous electrical conductor. Connect all electrical boxes, fittings and cabinets so as to provide effective electrical continuity and firm mechanical assembly. Maintain grounding continuity of interrupted metallic raceways with ground conductor.

J. Install complete conduit runs before pulling in wire or cable. Install raceways so that required conductors may be drawn in without injury or excessive strain to raceway or cable. Where raceway size is not indicated, follow applicable code.

K. Do not cross pipe shafts or ventilation duct openings with raceway. Route raceway to avoid present or future openings in floor, wall or ceiling construction, when so indicated on the drawings.

L. Keep end of raceways plugged or capped during construction.

M. For empty raceways over 10 ft. long, provide fish or pull wire. Pull wire shall consist of steel core nylon rope and terminal ball.

N. In cold rooms and food refrigeration, raceway installations shall be weatherproof and sealing fittings and compounds shall be employed at entries.

O. Concrete encased conduits run exposed inside the building shall have Class I concrete encasement. They shall be marked (stenciled) 10 ft. on centers, including in hung ceiling, with the notations, "Danger, High Voltage".

P. Damaged or deformed raceway is not permitted and shall be removed.

Q. Branch circuit conduits shall not be supported by the suspended ceiling or its supporting members, lighting fixtures, mechanical piping, or air-conditioning ducts.

R. Conduits located underground beyond the building shall be concrete encased and shall be installed as follows:

1. With a minimum of 30 in. top cover, above the conduits, and sloped away from the building.
2. Placed over well-tamped trench bottom and on concrete blocks 5 ft. on center. Conduits shall be anchored to prevent their movement. Conduit joints shall be staggered a minimum of 6 in. apart. All joints shall be watertight.
3. With a minimum separation between the electric and low voltage conduits of 12 in., if fiber only, or 24 in. if any copper is used present or future, of well tamped earth or concrete.
4. With entry into manholes through end bells.

S. For conduits and direct burial cable entering the building, and for the manholes preceding the conduits entry to the building, perform the following:

1. Plug all empty raceways.
2. Enter through floor or wall entrance fittings. The entrance fittings shall have a gland assembly which shall be capable of providing a seal around the conduit or cable to withstand 50 foot head of water without leakage. For greater than 50 foot head, the sealing assembly shall be similar to O-Z Gedney Type "FSK" or "FSCS".

T. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.

U. Galvanized Rigid steel conduit:

1. Paint male threads of field threaded conduit with graphite base pipe compound.

   a. Where located in slabs, the maximum outside diameter of the conduit shall be less than 1/3 the slab thickness. When locating in the slab, place conduits in a manner so as to not interfere with the placement of reinforcing bars or cause damage to structural members or structural support.
   b. Where located in concrete fill, the conduit shall have a minimum of 1 in. cover.
   c. Where located under the building, conduit shall be concrete encased.

V. Intermediate metal conduit:

1. Paint male threads of field threaded conduit with graphite base pipe compounds.
2. Where located in slabs, the maximum outside diameter of the conduit shall be less than 1/3 the slab thickness. When locating conduit in the slab, place conduits in a manner so as not to interfere with the placement of reinforcing rods or cause damage to structural members of structural support.
3. Where located in concrete fill, the conduit shall have a minimum of 1 in. cover.
4. In terrazzo floor finish, intermediate metal conduit is not permitted.
5. Where located under the building, conduit shall be concrete encased.
6. IMC shall not be used in hazardous areas or for direct burial.

W. Electric metallic tubing (EMT):

1. EMT is permitted to be used with the following limitations: for branch circuits only, and in dry locations (hung ceilings, hollow block walls and furred spaces).

X. Flexible steel conduit:

1. Flexible steel conduit "Greenfield", shall be used for the following applications: for short connections where rigid conduit or tubing is impracticable, from outlet box to recessed lighting fixture with minimum length of 4 ft. and a maximum length of 6 ft.
2. Connect the ground conductor to the enclosure or raceway at each end.

Y. Aluminum conduit:

1. Shall not be used in or on concrete or masonry, and shall not be used in wet locations.
2. Where routed through concrete and masonry walls and floors, conduit shall be painted with asphaltum.
3. Maintain clearance between aluminum conduits and surfaces for the following conditions: in moist locations, in interior spaces below exterior finished grade, and boiler rooms.
4. When connecting to steel surfaces, maintain galvanized-to-aluminum contact, or paint with asphalt base paint.

Z. Polyvinyl chloride conduit (PVC):

1. Cut ends square, ream smooth, wipe clean, apply approved solvent cement and quarter turn as drawing up tight.
2. Convert to steel conduit using adaptors when entering the building from underground locations.
3. Maintain a 3 ft. minimum clearance of PVC conduits from hot water and steam lines.

AA. Surface metal raceways shall be used only where shown on the drawings or as directed by the Architect.

BB. Provide expansion-deflection fittings at expansion joints and on length of runs in accordance with manufacturer's recommendations. Expansion-deflection fittings shall be of size as required complete with bonding jumper.

CC. For Hazardous Locations:

1. UL approved sealing fittings shall be installed, to prevent passage of explosive vapors as required by the NEC.

DD. For Wet, Damp, or Moist Locations:

1. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, much as refrigerated spaces, air conditioned spaces, or similar spaces.

3.4 SLEEVES

A. Sleeves shall be provided in accordance with the following guidelines:

1. Set required sleeves and inserts in place during progress of construction to avoid cutting of completed work.
2. Provide sleeves for raceway passing through floors and foundations. Determine exact location of sleeves in field to avoid interference with structural members or equipment of all trades.
3. Install sleeves rigidly so that proper position and alignment will be maintained during construction and pouring of concrete.

3.5 FIRE STOPS

A. Where wiring, conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, or floors, install an approved fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and shall completely fill clearances between raceways and openings.

B. Floor, exterior wall, and roof seals shall also be made watertight.

3.6 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

3.7 FIELD QUALITY CONTROL

A. Contractor shall perform continuity tests by testing the resistance of all feeder conduits from the service to the point of their final distribution using 1 conductor return. The maximum resistance shall be 25 ohms.

END OF SECTION

SECTION 26 05 34

ELECTRICAL BOXES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

B. This section is a Division 26 Basic Electrical Material and Methods section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.

B. Types of electrical boxes and fittings specified in this section include the following:

1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
4. Bushings.
5. Locknuts.
6. Knockout closures.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.

B. Installer's Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

C. Local Code and NEC Compliance: Comply with local code and NEC as applicable to construction and installation of electrical wiring boxes and fittings.

D. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.

E. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.

F. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical boxes and fittings.

B. Shop Drawings: Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Outlet boxes for concealed work shall be galvanized steel, 4 in. square or octagon (except as otherwise required by construction, devices or wiring) and as follows:

1. Above ceiling: 1-1/2 in. deep.
2. In ceiling or slab: 3 in. deep.
3. In wall for fixtures: 2-3/4 in. deep.
4. In wall for receptacles and switches: 2-1/2 in. deep.
5. With raised covers and fixtures studs where required.
6. Through-the-wall type are not permitted.

B. Outlet boxes for exposed work shall be galvanized cast iron or aluminum with threaded hubs. Except as otherwise required by construction, devices or wiring the outlet boxes shall be in 4 in. round x 2 in. deep for mounting on ceilings and 4 in. square x 2 in. deep for mounting on walls.

C. Outlet boxes without fixture or device, shall have blank cover.

D. Extension rings shall be provided as required to suit various conditions.

E. Grounding screw and cable wiring connector shall be provided as required by wiring method.

F. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides.

G. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

H. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.

I. Outlet boxes located outdoors and damp locations shall be weatherproof corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

2.2 JUNCTION AND PULL BOXES

A. Junction and pull boxes shall be made of galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panelboard trim.

B. Provide junction and/or pull boxes as noted or as required. All junction and pull boxes shall be accessible.

C. Junction and pull boxes located outdoors and in damp locations shall be galvanized cast iron with threaded hubs and gaskets.

D. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.

E. Provide barriers in junction boxes or pull boxes between:

1. 277/480 volt wiring energized from separate services.
2. 120/208 volt and 277/480 volt wiring.
3. Emergency and normal wiring.

2.3 FLOOR BOXES

A. Floor boxes shall be galvanized cast iron watertight, corrosion-resistant with brass covers and flanges. They shall be suitable for the conduits and the devices noted. Floor Boxes shall be similar to Hubbell Dualevel Series.

B. Flush poke-thru fire rated fittings shall be utilized where indicated on the drawings. Poke-thru fitting shall be adaptable for flush mounted duplex receptacle, combination receptacle/telephone jack or conduit adapter (flex) for power and communications. Fitting shall be similar to that as manufactured by Raceway Components Inc.

2.4 BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS

A. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of local codes, NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

C. Provide raintight "in use" outlets for interior and exterior locations exposed to weather or moisture.

D. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

E. Boxes separated by less than 24 inches shall be provided with firestop putty pads on the backside of all boxes exceeding 16 sq. inches in area. Provide Firestop putty pads on the back side for all outlet boxes within 24 inches of each other, in opposite sides, and at same elevation, in the same wall. Provide Firestop putty pads on the back side for all boxes in a wall or ceiling where the aggregate surface area of the outlet boxes exceeds 100 sq. inches per 100 sf of surface of wall or ceiling area. Firestop putty pads shall be Hilti CP617XI (9" x 9") for each box 16 sq inches or less.

F. Position recessed outlet boxes accurately to allow for surface finish thickness.

G. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

H. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.

I. Provide electrical connections for installed boxes.

J. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after

conductors are installed.

K. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

L. Subsequent to installation of boxes, protect boxes from construction debris and damage.

M. Set boxes square and true with the building finish. Boxes shall be secured to the building structure by adjustable strap irons.

N. Verify outlet locations in finished spaces with Architectural Drawings of interior details and finishes. Take caution in locating outlet to allow for overhead pipes, ducts, and variations in arrangement, thickness in finish, window trim and other Architectural Construction Details.

O. Correct any inaccuracy in locating outlets without additional expense to the Owner. Refer to Architect any condition that would place an outlet box in an unsuitable location, such as a molding, break glass in wall finish, or behind radiator.

P. Mount outlet boxes for similar equipment at uniform height within same or similar areas. Where mounting height or location of outlets is not shown or specified, mount outlet as best suited for equipment connected thereto, or as directed.

Q. Close all unused openings in outlet boxes with knockout closers manufactured for this purpose. Provide blank plates on outlet boxes in which no device is installed or device installed does not provide a suitable cover.

R. Provide barriers between switches connected to different phases for voltages exceeding 150 volts to ground.

S. Outlet boxes for fixtures recessed in hung ceilings, shall be accessible through the opening created by the removal of the fixture.

T. Securely fasten exposed outlet boxes by attaching to permanent inserts or lead anchors with machine screws. Adequately support all boxes during construction to prevent movement.

U. Boxes for concealed work shall be pressed steel galvanized and shall conform to UL's "Standard for Outlet Boxes and Fittings." Outlet boxes shall be provided with a galvanized steel cover or extension ring depth as required.

V. All ceiling fixture outlet boxes, except as noted, shall be 4" octagonal and 1-5/8" deep and with 3/8" fixture stud. Where cast in slab, boxes shall be open back concrete type.

W. Wall bracket outlets shall be 4" square and 1-5/8" deep with cover having 2-7/8" round openings and except for lampholders shall be furnished with fixture stud.

X. Junction outlets shall be the same as bracket outlets but without stud, furnished with covers to suit each condition and as directed. Where number of conductors exceed capacity of standard box, provide special size box.

Y. All outlet boxes for concealed convenience receptacles or local switches shall be 4" square and 1-5/8" deep with regular deep switch extension cover, except where installed on columns they shall be of sufficient depth so that conduits may be installed into these boxes in back of fireproofing. Outlet boxes for gang receptacles and switches shall suit space conditions.

Z. Boxes for use with surface mounted raceways shall be of the same construction and manufacture as the raceway.

AA. Boxes shall be of the cast type for switches and receptacles when installed on the exterior of the project. Such boxes shall be aluminum or malleable iron of the threaded hub type, with covers without projecting edges or corners

and with openings suitable for the devices to be contained therein. Outlet boxes and covers shall be galvanized or anodized and shall be gasketed.

BB. Except where special outlets are required, wall outlets for signaling systems shall be 4" square with single gang raised cover and bushed plate.

CC. Panel, junction and pull boxes:

1. Panel, junction and pull boxes shall be located clear of other trades equipment, accessible, supported from the building structure, and independent of the conduits.
2. Conceal junction and pull boxes in finished spaces.
3. Coordinate size of motor terminal boxes with motor branch circuit conduit and wiring.

3.2 GROUNDING

A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 26 05 43

UNDERGROUND SERVICE AND MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract.

B. Materials and Methods, Sections of Division 26.

C. Excavating, backfilling and Compacting and Division 3, concrete.

D. All excavation is unclassified.

E. Definitions:

1. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.
2. Unclassified excavation: Excavate and grade all materials that can be removed without drilling or blasting.

1.2 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for all underground service and manholes as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete instaltion.

1.3 SUBMITTALS

A. Product data for the following: Electrical Manholes, Duct Spacers.

B. Test reports as required for compaction and concrete work in Division 2 and 3.

1.4 QUALITY ASSURANCE

A. Compaction density test: ASTM D1557.

B. Owner will hire an independent soils laboratory to conduct in place moisture-density tests to insure that all work complies with this specification.

1. Notify Construction Manager or Owner’s representative at least 2 weeks prior to anticipated date of testing.
2. Contractor will pay additional cost if work is delayed due to his failure to notify Owner’s agent as specified above.

C. Comply with all aspects of “Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store conduit to avoid warping or deterioration.

B. Store plastic conduit on flat surface protected from direct rays of sun.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

A. Duct System: Multiple and single, conduits completely encased in concrete.

1. Separators: Plastic or other non-metallic, non-decaying material.
2. Concrete: 3500 PSI. Conform to Division 3 requirements.

B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.

2.2 MANHOLES

A. Electric Manholes: Types as indicated:

1. Concrete: 4500 PSI. Conform to Division 3 requirements.
2. Cover and frame: 36" diameter, gray cast iron with machine finished seat for perfect joint between cover and frame.
3. Provide floor drain with grate.
4. Provide cable racks, ladder rungs, 2 ground rods, cable pulling iron.
5. Provide manholes with 3500 psi, single pour concrete with reinforcement. Manholes shall have a minimum size of that noted on the Drawings. Increase the depth of the manholes to accommodate the raceway entry plus 2 ft. Provide sump pit in every manhole.
6. Locate raceway entries at right angles to and near end of the walls of the manhole. Seal openings watertight and paint exterior with 2 coats of asphaltic compound. Clear interior prior to energizing cables.
7. Frames and covers shall be heavy duty, cast iron, approximately 75 lbs., with machined bearing surfaces. Covers shall be solid, with indented top, and with inscription of identification as approved by the Engineer.
8. Windows for duct bank terminations shall be provided and shall be filled with concrete after duct placement.
9. Manhole shall have pulling eye irons located on the walls opposite the raceway entries. Pulling eye irons shall be imbedded in the concrete and fastened to the reinforcing rods.
10. All hardware provided in the manhole shall be hot dipped galvanized.
11. Double manholes shall include a 3 in. drain pipe at the floor between compartments.

B. Cable Racks: Galvanized, mounted on wall.

1. Equipment with minimum of 8 adjustable hooks; minimum 2 spare hooks on each rack.
2. Insulators: Best quality, high glazed porcelain; provide for each hook.
3. Space racks so each end of splices are supported horizontally.
4. Manhole shall be provided with cable racks. The rack supports shall consist of channels, approximately 2 ft. on center, similar to Globe Co. NO. G-3812.

C. Ladder Rungs: Galvanized, 12" x 12" x ¾" diameter.

1. Set with 7" clearance from rung to wall.
2. Ladder rungs shall be imbedded in the concrete and fastened to the reinforcing rods. The ladder rungs shall be located directly under the manhole cover, and they should clear all raceway entries.

D. Ground Rods: ¾" x 10' long, copper weld.

2.3 HANDHOLES

A. Provide heavy weight traffic handholes with 3500 psi, single pour concrete. Handholes shall have a minimum size of that noted on the Drawings. Handholes shall be provided complete with lifting ring or lifting eye, ribbed non-skid top surface and 4" high letters on cover spelling "ELEC" for power and "TELE" for size.

B. Handhole cover shall consist of a bolted 3/8 in. checkered steel plate with neoprene gasket.

C. Seal openings watertight and paint exterior with two coats of asphaltic compound.

2.4 WARNING TAPE

A. Provide plastic ribbon designed for direct burial in earth; yellow background with black warning letters.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANHOLES

A. Determine exact location of each manhole after careful consideration has been given to location of other utilities, grading, and paving.

1. Do not begin construction until location of each manhole has been approved by Architect/Engineer.

B. Construct manholes of type indicated in accord with applicable details.

1. Mix, place and cure concrete or set precast unit on non-expansive soil bed in accord with Division 3 requirements.

C. Set frames and cover:

1. Paint exterior with 2 coats asphaltic paint after inspection and approval by Architect/Engineer, and before setting.
2. In paved areas, set top of manhole covers flush with finished surface of paving.
3. In unpaved areas, set top of manhole covers approximately ½" above finished grade.
4. Where final grades are higher than top of manhole, install sufficient number of courses of grade rings between top of manhole and manhole frame to elevate manhole cover to final grade level.

D. The manhole chimney shall consist of a sufficient number of brick and mortar courses between top of manhole and manhole frame to reach the required level. The manhole frame shall be grouted to the chimney.

E. Frames and covers in roadways and paved areas shall be traffic type. In unpaved areas, frames and covers may be nontraffic type.

F. Install cable racks, ladder rungs and cable pulling iron.

G. Drive 2 ground rods into earth not less than 9' before manhole floor is placed.

1. Extend ground rods approximately 4" above manhole floor.
2. Drive a ground rod into the earth, before the floor is poured, at a convenient point close to the manhole wall. Ground rods shall protrude approximately four inches above the manhole floor.

3. Install ground wires around the inside perimeter of the manhole and anchor them to the walls. Connect the wires to the ground rods by the exothermic welding process to form solid metal joints, and bond the ground wires to the exposed non-current carrying metal parts of racks, etc., in the manholes. Also bond the wires to duct bank bare equipment grounding conductors.

3.2 DUCT BANK

A. Form all duct banks in square or rectangular fashion as shown, and place concrete so that voids around ducts are filled.

B. Provide minimum concrete thickness between duct of 2 inches.

C. Adjust final slopes on-site to coordinate with utilities and structure.

D. Install drain assembly with saddle cutouts for each conduit. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with ½ inch stainless steel straps to conduit assembly to prevent mechanical displacement. Connect to (piping drain) washed gravel sump 36 inch square by 36 inches deep.

E. Install on undisturbed soil where possible. Use pit run gravel and sand, placed in 8 inch lifts and compacted for backfill.

F. After installation, clean and swab ducts.

G. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.

H. Label conduit at stub-up and manhole penetrations in accordance with Section 26 05 53.

3.3 DUCT LINE

A. Duct lines shall be in accordance with the NEC, as shown on the drawings, and as herein specified.

B. Ducts shall be sloped to drain towards manholes and handholds, and away from building and equipment entrances. Pitch shall be not less than four inches in 100 feet. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 50 feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and stub-ups to equipment.

C. Underground conduit stub-ups to equipment inside of buildings shall be galvanized rigid steel, and shall extend a minimum of 10 feet clear of foundations. Stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel, and shall extend a minimum of five feet away from edge of slab. Install insulated grounding bushings on the terminations. Steel conduits shall be coupled to the ducts with suitable adapters, and the whole encased with three inches of concrete.

D. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/2-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

E. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable nonhardening compound to prevent the entrance of moisture and gases.

F. Install concrete encased ducts for both high and low voltage systems, unless otherwise shown on the drawings.

G. Duct lines shall consist of single or multiple duct assemblies encased in concrete installed with top of duct bank not less than 30 inches below established grade. Ducts shall be uniform in size and material throughout the installation, unless otherwise shown or specified.

H. Rigid, unplasticized, polyvinyl chloride spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of three inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed five feet.

I. Provide plastic spaces to maintain the following clearances between individual ducts:

1. For like services: Not less than three inches.
2. For power and signal services: Not less than 24 inches.

J. Couple the ducts with proper couplings. Couplings shall be staggered in rows and layers to insure maximum strength and rigidity of the duct bank.

K. The concrete envelope encasing the ducts shall extend not less than three inches beyond the outside walls of the outer ducts and conduits.

L. Within five feet of building and manhole and handhold wall penetrations, install reinforcing steel bars within the top and bottom of each concrete envelope to provide protection against vertical shearing. Where shown on the drawings, incorporate steel reinforcing in the duct envelopes.

M. Ducts shall be kept clean of earth, sand, or gravel during construction, and sealed with tapered plugs upon completion of each portion of the work.

N. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts, conduits and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth durable transitions.

END OF SECTION

SECTION 26 05 48A

NOISE AND VIBRATION CONTROL FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this section.

1.2 WORK INCLUDED

A. Vibration Isolation

B. Sealing Around Penetrations Through Walls and Slab

C. Sealant

D. Installation of flexible conduit between non-isolated construction and isolated construction, including mechanical equipment, fans, pumps, and bridging between isolated room-within-a-room and non-isolated adjacent construction.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Consult all other Sections to determine the extent of work specified elsewhere but related to this Section. This work shall be properly coordinated to produce an installation satisfactory to the Owner.

B. Installation of Transformers

C. Performance Lighting System

D. Electric Service Distribution

E. Concrete Housekeeping Pads

F. General Lighting Systems

1.4 DEFINITIONS

A. The term “or as approved” means the contractor may propose an alternate product, but the consultant shall be sole judge of acceptability of alternate products. The term “Contractor” as used in this Section refers to that contractor directly responsible for the supply and installation of the Electrical Systems, including noise and vibration control.

1.5 CONTRACTOR'S RESPONSIBILITY

A. The Electrical Contractor shall be directly responsible for the supply and installation of noise and vibration control equipment and work for the Electrical Systems.

B. The Contractor shall be responsible for providing a complete and suitable installation of isolation equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or on the drawings, shall be supplied by the Contractor without claim for additional payment.

C. The Contractor shall provide seismic restraints for all vibration isolation systems where required by code. The Contractor shall submit drawings and specifications, certifying that the installation will meet all local seismic restraint requirements. The Contractor shall also certify that none of the required seismic restraints will reduce the isolation efficiency of any vibration isolation systems.

D. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

1.6 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation equipment shall have the following responsibilities:

1. Determine vibration isolation for all equipment and systems in accordance with all codes and authorities having jurisdiction on this project.
2. Provide equipment isolation systems as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. The vibration isolation systems shall be guaranteed to have deflection indicated on the schedule on the drawings. Mounting sizes shall be determined by the mounting manufacturer, and the sizes shall be installed in accordance with the manufacturer's instructions.
6. The vibration isolator vendor shall ensure that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators. Where additional support structure is required, this shall be provided by vibration isolator vendor.

1.7 APPROVED MANUFACTURERS

A. All noise and vibration control apparatus shall be furnished by a single manufacturer who has supplied isolation equipment for at least five years. The vendor shall design and provide all hangers, isolators, bases, pads, sleeves and other devices specified, required, or detailed for the vibration isolation of all electrical equipment and conduit. The vendor for vibration control equipment shall be one of the following, or as approved:

1. Mason Industries Inc.
2. Amber-Booth
3. Kinetics Noise Control

1.8 BID PROPOSALS

A. The Contractor shall submit at the time of bidding the names and qualifications of the noise and vibration control supplier(s). If a supplier is not one of the pre-approved vendors, then the submittal shall be accompanied by a complete catalog of that supplier's products and samples of each proposed vibration isolator with reference to the specification part number.

1.9 SHOP DRAWINGS

A. Fully coordinated shop drawings for all vibration and noise control equipment and systems shall be submitted by the Contractor for review by the Owner's Consultants. These submittals shall state the performance of the noise and vibration control products to be provided, such as, but not limited to, the following: vibration isolator model or type, size and static deflection; isolator location shown on an outline of the isolated equipment; seismic restraints; installation details; locations of isolated conduit hangers on conduit layout plans; materials and details for penetrations, including penetrations by groups of conduits, and locations of acoustically sealed pull boxes.

B. Seismic restraints, including attachment calculations by the Seismic Restraint Manufacturer's licensed Engineer substantiating the seismic restraints are furnished and installed in accordance with local building codes. A registered professional engineer having a PE from the same state as the project, or state of restraint manufacturer shall stamp all analysis, or as required by local building codes.

1.10 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "Noise-Critical Spaces", require special attention (special acoustical provisions and restrictions). The table below designates the Noise-Critical Spaces:

Private Office	NC-35
Open Plan Work Area	NC-35
Phone Room	NC-35
Conference Room	NC-35
TV Studio	NC-25
News Room	NC-30
Interview Room	NC-25
Central Control	NC-40
Narration Booth	NC-20
Control Room	NC-35
Ingest	NC-35
Edit Rooms	NC-25
Audio Sweetening	NC-20
Audio Booth	NC-20
Playout	NC-30
Equipment Center	NC-45
Radio Studio	NC-20
Radio Control	NC-25
Green Room	NC-30
All other Occupied Space	NC-40
Private Office	NC-35
Open Plan Work Area	NC-35

B. Penetrations by ducts, pipes and conduit between Noise-Critical Spaces shall be sleeved, packed and sealed airtight with non-hardening sealant, and treated with Acoustically-Sealed Pull Boxes as described herein.

1.11 DESCRIPTION OF SYSTEMS

A. Vibration Isolation

1. Vibration isolators shall be installed to attenuate the vibration transfer from equipment such as transformers, lighting dimmers, lighting ballasts, controls and relays to reduce vibration.
2. Flexible connections shall also be supplied for conduit and wiring serving electrical equipment on vibration isolators to ensure complete isolation of such equipment.

B. Transformers

1. Transformers shall be located only where shown on the drawings. The noise sensitivity of this facility requires that all noise critical spaces be well isolated from transformer noise and vibration.

C. Sealing Of Penetrations

1. Electrical equipment generates “tuned” noise that can be very disturbing in performance spaces. Walls and doors within the cave can effectively isolate air-borne noises from noise critical spaces, but the effectiveness of sound isolating structures can be severely compromised by penetrations for electrical conduit. Proper sealing around and inside conduits passing through penetrations as described herein will maintain the integrity of the sound isolating structure.
2. Special “Acoustically Sealed Pull Boxes” shall be used where a group of conduits penetrate a noise critical wall. These heavy-duty, airtight pull boxes are used to reduce the leakage of sound through the conduit walls and thus through the structure.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Foam Rod

1. Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

B. Non-Hardening Sealant

1. Sealant for electrical penetrations shall be non-hardening polysulphide type.
2. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise sensitive walls that are also fire rated.

2.2 EQUIPMENT

A. General

1. All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.

B. Vibration Isolators

1. General

a. The static deflection of isolators shall be as given in the equipment schedule and specified below.
b. Vibration isolator sizes and layout shall be determined by the vibration isolator supplier to meet performance criteria below. Static deflections specified shall be met with equipment fully operational.

2. Isolator Type WP

a. Type WP (Waffle Pads) shall be minimum 5/16” thick neoprene pads ribbed or waffled on both sides. The pads shall be selected for 15% strain. Neoprene shall be bridge-bearing quality with a maximum durometer of 50. Where required to meet this strain criterion, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

(Type WP: Mason Industries Type W, Super W, or as approved.)

3. Isolator Type MWP

   a. Type MWP (Metal and Waffle Sandwich Pads) shall consist of two 5/16" thick ribbed or waffle neoprene pads sandwiching a 16-gauge stainless steel plate. The pad shall be designed for 15% strain. Neoprene shall be bridge-bearing quality with a maximum durometer of 50. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

      (Type MWP: Mason Industries Type WSW or as approved.)

4. Isolator Type RBA

   a. Type RBA isolators shall be designed with a neoprene element to provide isolation in tension, shear or compression. Neoprene shall be bridge bearing quality with a maximum durometer of 30.

      (Type RBA: Mason Industries Type RBA or as approved.)

5. Isolator Type DDNM

   a. Type DDNM (Double Deflection Neoprene Mounts) shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed, and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment. The strain on the neoprene shall not exceed 15%. Neoprene shall be bridge bearing quality with a maximum durometer of 50. DDNM mounts shall be selected for a static deflection of 3/8" unless otherwise specified.

      (Type DDNM: Mason Industries Type ND or as approved.)

6. Isolator Type DDNH

   a. Type DDNH (Double Deflection Neoprene Hangers) shall consist of a molded neoprene element in a steel hanger box. A neoprene sleeve shall be located where the lower hanger rod passes through the steel box supporting the isolator, such that the hanger rod cannot contact the steel hanger body. The diameter of the clear hole in the mounting box shall be at least 3/4" larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30º arc. When installed, the hanger box shall be allowed to rotate through a full 360º arc without encountering any obstructions.
   b. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.3" with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer of 50.

      (Type DDNH: Mason Industries Type HD or as approved.)

7. Isolator Type SPNM

   a. Type SPNM (Spring and Neoprene Mounts) shall be free standing and laterally stable without any housing. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall be not less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
   b. Unless otherwise specified, the minimum static deflection of SPNM isolators for equipment mounted on grade slabs shall be 1", and the minimum static deflection for equipment mounted above grade level shall be 2".
   c. Two Type WP isolation pads sandwiching a 16-gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate.
   d. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

(Type SPNM: Mason Industries Type SLFSW or as approved.)

8. Isolator Type SPNH

   a. Type SPNH (Spring and Neoprene Hangers) shall consist of a steel spring in series with a neoprene element. The spring shall have a minimum additional travel to solid equal to 50% of the specified deflection. The neoprene element shall have a static deflection of not less than 0.3" with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer of 50.
   b. Unless otherwise specified, the static deflection of SPNH hangers shall be 2".
   c. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30º arc. A neoprene sleeve shall be inserted in the steel hanger box where the lower hanger rod passes through it, such that the hanger rod cannot contact the steel hanger body. The diameter of the clear hole in the mounting box shall be at least 3/4" larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360º arc without compromising a minimum clearance of 1".

   (Type SPNH: Mason Industries Type 30N or as approved.)

9. Neoprene Mounting Sleeves

   a. Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

10. Acoustically Sealed Pull Boxes

   a. Sides and cover shall be formed of minimum 14-gauge cold rolled steel. Inside surfaces of sides and cover shall be lined with 1" thick, neoprene-coated duct liner board of 3 pcf density. Entire perimeter of closure shall be sealed with 1" x 1/4" closed-cell sponge neoprene sound seal. Sides of the box shall be sealed airtight to the wall with non-hardening sealant on foam backer rod. Conduit penetrations through wall shall be packed and caulked as described herein.

PART 3 - EXECUTION

3.1 GENERAL

A. Ballasts, relays, dimmers, equipment controls and all transformers shall be located as shown on the drawings. If not shown, location is subject to review by architect and acoustical consultant prior to installation. Under no circumstances shall such devices be located within noise critical spaces or on walls, slabs or ceilings that are common to such spaces.

3.2 TRANSFORMERS

A. All transformers shall be supported on Type DDNM or Type DDNH isolators. All wiring connections to transformers shall be made with flexible conduit having sufficient slack so as not to impede movement of equipment on isolators.

B. Transformers shall not be hung from or supported on other equipment, pipes or ductwork installed on vibration isolators, but shall be supported on or suspended from building structure.

3.3 DIMMER RACKS

A. Dimmer racks and other lighting equipment containing transformers, fans, choke coils or relays shall be installed on Type MWP isolation pads and shall be located a minimum of 3" from adjacent walls. Conduit within the dimmer rooms shall be suspended on Type DDNH neoprene hangers.

3.4 MOTORS AND ELECTRICAL EQUIPMENT

A. All wiring connections to motors and electrical equipment supported on Type SPNM or Type SPNH isolators shall be made with a slack U-shaped section of flexible conduit. Wiring connections to motors and electrical equipment supported on Type DDNM and or Type DDNH isolators shall be made with a slack U-shaped flexible conduit. Flexible conduit and cable shall be capable of and recommended for such curvature.

3.5 SOUND SYSTEM RACKS

A. All sound and communication racks shall be mounted on Type MWP isolators.

3.6 ACOUSTICALLY SEALED PULL BOXES

A. Acoustically sealed pull boxes as described herein shall be installed at one side of each penetration at noise critical walls and slabs where the pull box exceeds 8” in at least one dimension.

3.7 PENETRATIONS OF WALLS AND SLABS

A. All conduit and cable penetrations of noise critical spaces shall be sleeved, packed and caulked airtight.

B. Where a conduit or cable passes through such a wall or slab, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be larger than the external diameter of the conduit passing through it by 2” for conduit 2” and over and by 1” for conduit under 2”. After all conduit is installed, the Electrical Contractor shall check the clearance and correct it, if necessary, to within 1/2”. The void shall be packed full depth with glass fiber; install foam backer rod on both sides, recessed into the sleeve by 1/2”. Cover the backer rod 1/2” deep with non-hardening, non-aging sealant. Alternatively, the void between sleeve and conduit shall be filled full-depth with GE silicone sealant Type RTV6428 or approved material with equal density and flexibility. For penetrations in fire-rated assemblies, use approved non-hardening, non-shrinking fire stop putty in lieu of the sealant and foam rod.

C. Where conduit crosses a building expansion joint between new and existing buildings, an 18” length of flexible conduit shall be used to bridge between the two constructions. Rigid conduit shall not be acceptable.

3.8 FIELD QUALITY

A. Contractor shall work in accord with best trade practices, shall fabricate and install all items in accordance with manufacturer's recommendations and Architect's directions, and shall consult and coordinate with trades doing adjoining work in order to provide an installation of first class quality.

3.9 TESTING AND ADJUSTMENT

A. Contractor shall test and adjust noise and vibration control products and installations to achieve specified performance.

3.10 CONTRACTOR'S REPORT

A. The vibration isolation manufacturer shall inspect and approve the installation of the vibration isolators, and shall submit a report to the Architect and Acoustics Consultant which verifies that all of the isolators for electrical equipment has been properly installed and that the installation is in full conformance with the specification. The report shall contain the type and measured static deflection of all spring isolators provided.

3.11 SITE ACCESS

A. During installation of equipment, Contractor shall arrange for access as necessary for inspection of isolation and noise control equipment by Architect and Acoustics Consultant.

3.12 CONSULTANT'S INSPECTION

A. Upon completing installation and adjustment for suitable operation of all work specified under this section, the Contractor shall notify in writing the Architect, who will schedule an inspection by the Acoustics Consultant. The letter shall certify that all work specified under this section is complete, operational and adjusted in every respect, and that all work is ready for the completion checkout. Defective equipment and installation shall be repaired at the cost of the Contractor, and another inspection shall be scheduled.

B. In the event that a second (or subsequent) inspection is required, the Contractor shall reimburse the Owner for travel, food and accommodation expenses incurred by the Consultant and passed on to the Owner.

C. For each inspection, workmen shall be furnished to perform such functions as are necessary for inspection of the equipment.

END OF SECTION

SECTION 26 05 49

SEISMIC DESIGN

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Seismic restraints and/or bracing shall be provided for selected electrical equipment and wiring methods as described hereinafter. These seismic design requirements are complementary to the requirements specified elsewhere for the fastening and support of electrical work. Nothing on the drawings or elsewhere in these specifications shall be interpreted as a reason to waive any of the requirements of this Seismic Design section.

B. This project is located in Seismic zone 2.

C. Provide seismic support for the following items:

switchboards
Generators, day tanks, and associated piping
Uninterruptible power supplies and battery racks
Automatic transfer switches
Emergency panelboards
All lighting fixtures and exit signs
Emergency battery packs and/or central systems
Fire alarm/detection systems
Raceways associated with emergency lighting/power, fire alarm/detection system
Dry type transformers
Raceways 2½" and larger suspended on individual hangers longer than12 inches, and all raceways on trapezes.

D. All seismic restraint and isolation devices, braces, and supports shall be capable of accepting without failure forces produced by seismic acceleration (expressed in multiples of the acceleration of gravity "G") based on the level grade of the attachment of the equipment support system. For design purposes, the following acceleration levels shall be used.

DESIGN LEVEL OF ACCELERATION AT EQUIPMENT CENTER OF GRAVITY			
ELEVATION ABOVE GRADE	RIGIDLY FLOOR OR WALL MOUNTED EQUIPMENT	RESILIENTLY MOUNTED AND/OR SUPPORTED FROM CEILING OR STRUCTURE ABOVE	LIFE SAFETY EQUIPMENT (FIRE ALARM, EMERGENCY
SEISMIC ZONE 2 A_v = 0.10 TO 0.19			
BELOW GRADE UP TO 20 FEET ABOVE GRADE	0.125 "G"	0.500 "G"	
21 FEET – 300 FEET	0.500 "G'	0.750 "G"	
301 FEET – 600 FT.	0.750 "G"	1.000 "G"	1.000 "G"

1.3 OEM EQUIPMENT ISOLATION PACKAGES

A. Internal and/or External Systems

1. Substitution of internally or externally isolated or restrained equipment instead of the isolation and restraints specified in this section is acceptable provided all requirements of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certifying that the seismic restraints are in full compliance with these specifications. Letters from field offices and representatives are unacceptable.
2. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the preceding.
3. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure.

1.4 SUBMITTALS

A. Seismic Certification and Analysis

1. Provide seismic restraint calculations certifying that all seismic restraint devices are capable of accepting, without failure, the "G" forces shown in the table above. Calculations shall be provided for all connections of the equipment to the structure. All performance of products (such as strut, cable, anchors, clips, etc.) associated with restraints must be supported by the manufacturer's data sheets or certified calculations. For roof mounted equipment, both the seismic acceleration and wind loads shall be calculated. The highest load shall be used for the design of the restraints and isolators.
2. Calculations to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience.
3. Analysis must indicate calculated dead loads, derived loads, and materials used for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.

1.5 RELATED WORK

A. Housekeeping Steel

1. Where steel sills are called for under a piece of electrical equipment, attachment shall be designed and certified according to this section by the seismic/isolation supplier.
2. Steel sills shall be sized to accommodate a minimum of six inches of clearance all around the equipment and its mounting package. In addition, ¾" clearance shall be provided between the electrical equipment and the steel sills so that the space may be kept clear of debris that would inhibit the isolation.

B. Supplementary Support Steel

1. Structural support and connections for all electrical equipment, including roof mounted equipment, specified in other sections shall comply with the seismic requirements of this section.

C. Design Responsibilities

1. Include the following in the responsibility of the seismic equipment supplier:

a. Determine guidelines for vibration isolation and restraint size and location.
b. Provide equipment vibration isolation and seismic restraints as required.
c. Guarantee specified isolation system deflections.
d. Provide installation instructions, drawings, and field supervision to insure proper installation and performance of systems.

e. Certify correctness of installation upon completion.

1.6 QUALITY ASSURANCE

A. Installation of electrical equipment shall, as a minimum, be installed in accordance with the latest applicable edition of the Building Code of the State of New York.

B. Listing and Labeling: Provide products that are Underwriters Laboratories listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms “Listed” and “Labeled”: As defined in the “National Electrical Code”, Article 100.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available manufactures: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. AVNEC, Inc. of Floral Park, NY
2. Mason Industries, Inc. of Hauppage, NY
3. Vibration Mounting and Control of Butler, NJ
4. Consolidated Kinetics of Columbus, OH

B. Attachments

1. Hardware and devices such as beam clamps, anchor bolts, cables, and cast-in-place plates must be by this section’s supplier to ensure seismic compliance and certification. Alternate anchor bolts may be provided so long as the sizing and dimensions on the seismic submittals are followed:

2.2 SEISMIC RESTRAINTS AND VIBRATION ISOLATORS

A. General

1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the “G” forces as determined by the seismic certification and calculations described above.
2. Corrosion protection for both indoor and outdoor applications shall be as follows:
   a. Springs – Cadmium plated, zinc electroplated, or powder coat.
   b. Hardware – cadmium plated
   c. All other metal parts – hot spray or hot dipped galvanized.
3. All seismic restraint devices:
   a. Shall maintain the equipment in a captive position and not short circuit isolation devices during normal operating conditions.
   b. Shall have provisions for boiling and/or welding to the structure.

B. Seismic Restraint Types

1. Restraints for suspended systems
   a. Isolated systems and, where required elsewhere by this specification, lighting fixtures – braced with multiple steel cable with approved fastening devices to equipment and structure.
   b. Non-isolated systems – braced with structural steel strut with approved fastening devices to equipment and structure.

2. Restraints for systems rigidly connected to walls or floor or ceiling slabs.

a. Rigid attachment to structure using wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Power shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with ICBO National Standards for seismic anchorage.

C. Vibration Isolator Types

1. For Dry Type Transformers –

a. Double deflection neoprene isolators encased in ductile iron or steel casing.

2. For Emergency Generators on Grade – Pad Type Elastomer Isolator

a. Neoprene pad shall have 0.75" minimum thickness and shall have opposed cylindrical supports spaced on one inch centers to provide uniform deflection of 0.1 inch under rated load. Supports shall be connected under in the center by an 1/8" tear strip to facilitate trimming to desired size in one inch increments. Supports will also have through holes to accept up to 3/8" bolts without special drilling or coring.
b. 1/16" galvanized steel plate between multiple pad layers.
c. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
d. When bolting is required for seismic compliance, neoprene washers and bushings shall be provided to prevent short circuiting.

3. For Conduit Risers – Resilient Conduit Anchors and Guides

a. One inch of six pound density Fiberglass packed around the conduit.

2.3 FLEXIBLE CONNECTORS

A. All connectors to the generator and day tank shall be installed on the equipment side of shutoff valves. Piping shall be supported and/or anchored to resist pipe movement beyond the allowable movement of the flexible connector.

PART 3 – EXECUTION

3.1 APPLICATION

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all submittal data.

B. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

3.2 INSTALLATION

A. Equipment shall be restrained as indicated in the table at the end of this specification.

B. Additional Requirements

1. All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators, and restraints.
2. Spring isolators shall be installed after all equipment is installed without changing equipment elevations.
3. After the entire installation is complete and under full operation load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators.
4. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment's movement shall be free in all directions.
5. All electrical connections to isolated equipment such as transformers and generators shall be in flexible conduit.
6. Use wedge type expansion bolts to bolt the base to the structure.

3.3 SEISMIC RESTRAINTS

A. Installation

1. All equipment specified to receive seismic support shall be restrained per the table at the end of this section.
2. All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted, or welded to the structure to comply with the required acceleration. Calculations that determine that isolated equipment movement may be less than the operating clearance of snubbers (restraints) do not preclude the need for snubbers. All equipment must be positively attached to the structure.
3. Lighting fixtures shall be seismically restrained in accordance with the following:

    a. All lighting fixtures and exit signs throughout the building shall be provided with seismic restraints.

    b. Lighting fixtures recessed into suspended ceilings shall be supported from the ceiling structure by not less than two earthquake clips, or other approved supports, each capable of supporting 50% of the fixture weight.

    c. Lighting fixtures surface mounted on the underside of suspended ceilings shall be provided with at least two supports, each independently connected to the slab above with cable type restraints as described hereinbefore for suspended systems and each capable of supporting 100% of the fixture weight.

    d. Pendant mounted lighting fixtures shall be supported from the slab above utilizing approved fixture hangers designed to permit a swing of at least 20" in any direction without damage to the fixture, hangers, or structure. Each support shall be capable of supporting 100% of the fixture weight. If there are obstructions preventing the free swing, provide additional support bracing to restrain 50% of the fixture weight. Pendant mounted fixtures below suspended ceilings shall be supported at the ceiling level and shall have cable to the slab above.

    e. Lighting fixtures surface mounted directly to ceiling slabs, walls or structural elements shall be rigidly attached using restraints specified hereinbefore for rigidly connected ceiling slabs or walls.

4. All horizontally suspended conduit systems shall use restraints for non-isolated suspended systems. Spacing of seismic bracing shall be according to table below. All bus ducts and cable trays passing through floors shall be bolted at each floor level or secured above and below each floor with riser clamps. This restraint shall be in addition to the spring type hangers specified.

SEISMIC BRACING TABLE		
EQUIPMENT	ON CENTER SPACING	
	TRANS-	LONGITU-
CONDUIT	40 FEET	80 FEET

5. For all seismically supported trapeze supported conduit, the individual conduits shall be transversely and vertically restrained to the trapeze support at the designated restraint locations. Restrain at least every third trapeze hanger transversely and every fifth one longitudinally as well as the trapeze on both sides of every change of direction.
6. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:

    a. Flanges of structural steel beams.
    b. Upper truss chords in bar joists.
    c. Cast in place or drilled and shielded inserts in concrete structures.
7. For dry type transformers suspended from the slab above, use isolators with 0.20" deflection and seismic restraints for isolated, suspended equipment.
8. Where conduits pass through cored or sleeved holes, the holes shall be a maximum of 2" larger than the conduit O.D. Pack the space with fireproofing material. No additional horizontal seismic bracing is required at these locations.
9. All non-isolated floor or wall mounted equipment such as switchboards, panelboards, etc. which require restraint shall use restraint for rigid attachment. For floor mounted transformers up to and including 300 KVA, use isolators with a 0.30" deflection and rigid attachment seismic restraints. For larger transformers, provide a calculation for the isolators and restraints required. Where base anchoring of equipment such as switchboards is insufficient to resist seismic forces, additional restraints for suspended, non-isolated equipment shall be located above the unit's center of gravity to suitably resist "G" forces specified.

10. Emergency generators shall be a "factory package" mounted on rigid base consisting of a full length skid or rail of structural steel on each side and cross bracing members of each end. An additional auxiliary matching rigid base shall be furnished and installed anchored to the floor as dunnage. The emergency generator set shall be resiliently isolated from the building structure or grade by means of bare stable spring isolators (with 1.50" deflection and 0.10" deflection respectively) mounted between the rigid base of the generator and the matching auxiliary base. Provide seismic restraints for rigid attachment.

3.4 INSPECTION

A. Upon completion of installation of all vibration isolation and seismic restraint devices, a certification report prepared by the manufacturer shall be submitted in writing to the architect/engineer indicating that all systems are installed properly and in compliance with the specifications. The report shall identify those areas that require corrective measures or certify that none exist. Any field coordination type changes to the originally submitted seismic restraint designs must be clearly defined and detailed in this report.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Electrical Requirements."

1.2 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Buried electrical line warnings.
2. Identification labeling for raceways, cables, and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.

B. Related Sections: The following Sections contain requirements that relate to this Section;

1. Division 9 Section "Painting" for related identification requirements.
2. Division 26 Section "Wires and Cables" for requirements for color coding of conductors for phase identification.

C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.

C. Schedule of identification nomenclature to be used for identification signs and labels.

D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.

B. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape with magnetic tracer strip not less than 6 inches wide by 4 mil thick. Printed legend indicative of general type of underground line below.

C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.

D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and red letters on white face for emergency power. Plastic laminate shall be punched for mechanical fasteners.

E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide ¼-inch grommets in corners for mounting.

G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

H. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of local codes and the NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 CONDUIT IDENTIFICATION

A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.

B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches

below finished grade. Where multiple lines, installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

C. Install line marker for underground wiring, both direct-buried and in raceway.

D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:

1. Fire Alarm Systems: Red.
2. Fire Suppression Supervisory and Control System: Red and Yellow.
3. Mechanical and Electrical Supervisory System: Green and Blue.
4. Telephone System: Green and Yellow.
5. Tag or label conductors as follows:
   a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.
   b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
   c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.

E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

208/120 Volts		Phase	480/277 Volts
Black	A	Brown	
Red		B	Orange
Blue		C	Yellow
White	Neutral	Gray	
Green	Ground	Green	

G. Use conductors with color factory-applied the entire length of the conductors except as follows:

1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
   a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
   b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal

and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.

H. Power Circuit Identification:

1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.

I. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment including central or master unit of each electrical system. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency power. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchboards.
   d. Motor starters
   e. Pushbutton stations.
   f. Power transfer equipment.
   g. Contactors.
   h. Remote-controlled switches.
   i. Dimmers.
   j. Control devices.
   k. Transformers.
   l. Power generating units.
   m. Telephone switching equipment.
   n. Fire alarm master station or control panel.
   o. Lighting control panel.
   p. Multi-outlet raceways shall have each outlet labeled with panelboard and circuit number.

K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.

L. Fire Pump Service Identification: A placard shall be externally installed on the Fire Pump primary disconnecting means stating “Fire Pump Disconnecting Mean.” The lettering shall be at least one inch in height. In addition, a placard shall be placed adjacent to the Fire Pump controller stating the location of this disconnecting means and the

location of the key (if the disconnecting means is locked).

M. Electrical Service Room Distribution Placard: In each of the main electrical rooms, provide a single line riser diagram placard of the entire electrical distribution fed from that room. The placard shall also identify where other services are located per NEC 230.2(e). The riser diagram shall be framed under glass and mounted on the wall in the electrical room. The print shall be of diffusion transfer process to eliminate fading.

N. Arc Flash Warning Signs: Provide arc flash warning signs at all panelboards, switchboards, control panels, meter enclosures, starters, motor control centers, transfer switches, etc., that may be subject to inspection or repair. Warning signs shall be white letters on a red background with informative text in black on a white background. Signs shall be permanently affixed directly to the equipment in a readily visible location or located adjacent to the equipment with a smaller warning label on the equipment that directs maintenance personnel to the more informative sign. Warning sign data shall be appropriate and specific to each piece of equipment or device and shall identify flash hazard category, incident energy, VAC shock hazard, flash protection boundary, limited approach boundary, restricted approach boundary, restricted approach boundary, and prohibited approach boundary. Warning sign shall also indicate all recommended protective equipment. Calculations supporting the data on each warning sign shall be completed by a licensed professional engineer hired by the Contractor and presented to the owner in book form for future reference. Arch flash warning signs shall be in accordance to the most stringent of NFPA 70E, NFPA 70, and OSHA.

END OF SECTION

SECTION 26 08 00

COMMISSIONING

GENERATOR AND ATS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, electrical generator and automatic transfer switch as shown on the drawings and hereinafter specified.

B. Equipment and wiring shall be provided and installed by Electrical Contractor under this contract.

1.3 SUBMITTALS

A. Materials list with manufacturer, style, series or model identified.

B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer

1.3 QUALITY ASSURANCE

A. Installer's Qualifications: Firms with at least 5 years successful installation experience on projects utilizing switchboards and panelboards similar to those required for this project.

B. All work shall be performed in accordance with all rules, regulations, and all applicable codes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store equipment in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.

B. Handle equipment carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation, wiring, and commissioning within owners pre-arranged time frame.

PART 2 - PRODUCTS

2.1 LOAD BANKS: Refer to Section 26 05 05.

2.2 WIRES AND CABLES: Refer to Section 26 05 19.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. The following work shall be performed by the Contractor, Generator representative, and ATS representative.

COMMISSIONING

After the complete installation of generator and ATS, these individual equipment's shall be tested as stand-alone, then followed by testing of the complete system as a whole. This process is divided into two parts. Part one, Static proof of the equipment, and part two, dynamic proof of the system. Throughout these two parts, all vendors and contractors shall simultaneously perform their roles.

Provide temporary load bank for testing/commissioning

Signatures are required by each vendor and contractor for both the static and dynamic parts of the testing. All static testing check lists shall be filled out and signed and the dynamic testing sectioned shall be signed by all.

PART 1 – STATIC EQUIPMENT TESTING

Generators

Generator

- ☐ Provide Warranty Validation Sheet , Start-up Validation and Pre-Inspection
- ☐ (Inspections to be performed by factory authorized personnel only)
- ☐ Start-up Date _____/_____/_____
- ☐ Authorized Representative Performing start up :_____
- ☐ Technician Name (print)_____
- ☐ Owner or Owner's Representative Name (print)_____
- ☐ Genset Nameplate Data
- ☐ Model # _____
- ☐ Engine Serial # (found on engine block)_____
- ☐ Fuel Type □Diesel □NG □LP Vapor □Liquid LP
- ☐ RPM
- ☐ HZ
- ☐ Utility Service kW_____ kVA_____
- ☐ Volts_____ Phase_____

- ☐ Amps Per Terminal
- ☐ Phase Rotation
- ☐ Adjustments for location Altitude _____
- ☐ Is the equipment installed in an outdoor weather protected housing? _____
- ☐ Is there emergency lighting available at the equipment room ?_____
- ☐ Is the mounting surface(s) visually properly constructed and leveled?_____
- ☐ Is the mounting surface made from non-combustible material?_____
- ☐ Has the wood skid been removed?_____
- ☐ Is the radiator duct connected to the air vent or louver?_____
- ☐ Is there an adequate/dedicated fuel supply?_____
- ☐ Are the fuel filters installed?_____
- ☐ Is fuel transfer tank pump motor connected to the corresponding voltage?
- ☐ Is the fuel transfer tank pump connected to the emergency power source?_____
- ☐ Are flexible fuel lines installed between the engine fuel inlet and fuel piping?____
- ☐ Are the manually operated fuel and cooling water valves installed allowing manual operation or bypass of the solenoid valves? _____
- ☐ Does the exhaust line have flexible connector(s)?_____
- ☐ Is the flexible connector(s) straight?_____
- ☐ Is there an exhaust line condensate trap with a drain installed?_____
- ☐ Is the specified silencer installed and are the hanger and mounting hardware tightened?_____
- ☐ Is a heat-isolating thimble(s) installed at points where exhaust lines pass through combustible wall(s) or partition(s)? _____
- ☐ Is the exhaust line free of excessive bends and restrictions?_____
- ☐ Is the exhaust line installed with a downward pitch toward the outside of the enclosure?_____
- ☐ Is the exhaust line protected from entry by rain, snow, and animals?_____
- ☐ Are individuals protected from exposure to high temperature exhaust parts and are hot parts safety decals present? _____
- ☐ Does the nameplate voltage/frequency of the generator set and transfer switch match normal/utility source ratings? _____
- ☐ Do the generator set load conductors correctly connect to the circuit breakers and/or the emergency side of the transfer switch?_____
- ☐ Are the load conductors, remote start loads, battery charger cables, and remote annunciator leads installed in separate conduits?_____
- ☐ Is the battery charger AC circuit connected to the corresponding voltage and energized? _____
- ☐ Is the tank heater AC circuit connected to the corresponding voltage and energized?_____
- ☐ Is the battery(ies) filled with electrolyte and connected to the charger?_____
- ☐ Are the engine starting cables connected to the battery(ies)? _____
- ☐ Inspect unit for freight damage (ensure components are tight).
- ☐ Verify that the engine is filled with oil, the cooling system is filled with coolant/antifreeze and battery(ies) are filled with acid.
- ☐ Inspect for proper belt alignment and tension.
- ☐ Inspect all electrical connections in control panel verify connections are tight and secure.
- ☐ Open all water and fuel valves. Temporarily remove the radiator cap to eliminate air in the cooling system. Replace radiator cap.

- ☐ Prime the fuel system.
- ☐ Press the LED test, if equipped on controller. Do all the LEDs on the panel illuminate?_____
- ☐ Place the generator set engine control switch in the OFF/RESET position. Observe Not-in-Auto LED and alarm, if equipped, on the controller.
- ☐ Open the generator main line circuit breakers.
- ☐ Verify the presence of lube oil in the turbocharger, if equipped.
- ☐ Verify power on to the water/oil heaters and fuel lift pumps.
- ☐ Place the generator set engine control switch in the RUN position. Allow the engine to start and run.
- ☐ Check the battery charger voltmeter and ammeter for battery charging indication.
- ☐ Verify whether there is sufficient oil pressure.
- ☐ If the speed is unstable, adjust.
- ☐ Adjust the AC output voltage to match the utility voltage using the voltage adjusting control.
- ☐ Allow the engine to reach normal operating coolant temperature. Check for oil, coolant, and exhaust leaks. Check and tighten all hose connectors and clamps.
- ☐ Manually overspeed (if applicable) the engine to cause an engine shutdown (71 Hz on 60 Hz models). Place the generator set engine control switch in the OFF/RESET position.
- ☐ Check the coolant level, add coolant as necessary, and replace the radiator cap. Verify that all hose clamps are tight and secure. Place the generator set engine control switch in the RUN position.
- ☐ Verify the engine low oil pressure and high coolant temperature shutdowns.
- ☐ Check the overcrank shutdown.
- ☐ Check and verify any additional protective devices
  List them: _____, _____, _____
- ☐ Place the generator set engine control switch in the OFF/RESET position.
- ☐ Check the utility source voltage, frequency, and phase sequence on three-phase models. The generator set must match utility source and load.
- ☐ Verify that all the wire connections from the generator set to the transfer switch and optional accessories are tight and secure.
- ☐ Close the generator set main line circuit breakers connected to the transfer switch.
- ☐ Place the generator set engine control switch in the RUN position.
- ☐ Check the generator set voltage, frequency, and phase sequence on three-phase models. The generator set must match utility source and load.
- ☐ Place the generator set engine control switch in the OFF/RESET position.
- ☐ Place the transfer switch in the TEST position. NOTE: Obtain permission from the building authority before proceeding. This procedure tests transfer switch
  operation and connects building load to generator set
  power.
- ☐ Readjust frequency to 60 Hz with total building loads.* Verify no load frequency to be no more than 62.0. Adjust if necessary. (Mechanical governor only)
- ☐ Verify that the current phase is balanced for three phase systems.
  List them _____
- ☐ Release the transfer switch test switch. The transfer switch should retransfer to the utility source after appropriate time delay(s).
- ☐ Allow the generator set to run and shut down automatically after the appropriate cool down time delay(s).
- ☐ Set the plant exerciser with load to the customer's required exercise period, if equipped.
- ☐ Verify that all options on the transfer switch are adjusted and functional for the customer's requirements. Transfer Switch delay setting: TDES____TNE____TDN____TDEC____

- ☐ In phase monitor ON_____ OFF_____
- ☐ Verify that all options on the transfer switch are adjusted and functional for the customer's requirements.
- ☐ Run the the load bank test.
  Time of Day
  Gen. Amps _____Gen. Volts _____Gen. Freq._____
  Amb. Temp._____Oil Press._____
  DC Charg. Volts._____
  Water Temp. Running_____
- ☐ Alarms
  Low oil pressure pre alarm
  Low oil pressure alarm
  High water temp pre alarm
  High water temp alarm
  Low water temp pre alarm
  Over crank
  Over-speed (this alarm is generated via test setting in controller not by
  actual over-speed of engine)
  Low fuel level pre alarm
  Low coolant level pre alarm
  Switch not in auto
  Emergency stop button
- ☐ Factory Technician Signature_____
- ☐ I _____received training on
  _____.
  Please print name of person receiving training and have him/her sign his/her name
  Date
  Notes
  _____
  _____
  _____
  _____

Pre-start checks to be made

- ☐ Check and/or fill lube oil level per engine manufacturer's recommendations (and note). Also, check all hoses and clamps for tightness.
- ☐ Check and/or fill engine coolant per engine manufacturer's recommendations (and note). Also, check all hoses and clamps for tightness.
- ☐ Inspect all electrical connections for completion, quality, and safety per installation guide. In the case where items are not met, abort start-up until completed or corrected satisfactorily. (Consult the factory with questions.)
- ☐ Inspect unit mounts for completion. Rubber pad type mounts should be installed between unit base and concrete or sub-base tank. The anchor bolts should be double-nutted and not tightened to base to allow for slight movement. (See installation guide.) Note: Gen-set should never be mounted tightly to concrete due to inconsistencies in the surface that could cause twisting in the drive alignment and result in damage.
- ☐ Spring type mounts must be installed per Installation Guide.

- Inspect and/or make battery connections with respect to polarity and voltage. Incorrect installation can damage equipment.
- Inspect transfer switch installation. Be sure the ATS is free from all foreign materials (filings, metal particles and tools, etc.). Check all connections. Manually transfer before energizing.

Now that all the above checks are made and complete, the gen-set can be started in the manual position. (Note: do not transfer load at this time.)

- With gen-set running, check engine gauges and unit meters (oil pressure, water temperature, battery ammeter, AC voltage, and AC frequency) to see that the unit is operating accordingly. Also at this time check phase rotation of both normal and emergency sources and check voltage of both sources for proper match. (Always perform these checks at the ATS if possible.) If phase rotation is reversed, stop gen-set and correct. If voltage is incorrect readjust. When correct, stop gen-set. Put gen-set switch in auto position. (Unit should not start.)
- To Test system, shutting off utility power is recommended but not always possible. If necessary follow the ATS test procedures to put the system online. Make recordings of load test on warranty validation sheet. Include all meter readings. Watch for proper operation, leaks, etc., and make notes of such.
- When normal power is restored the ATS will timeout, re-transfer to normal, then, in most cases allow for engine cool down before stopping automatically. (Timing functions may vary.)

Final mechanical checks and visual inspection

- Check for oil leaks, note and/or repair as necessary.
- Check for coolant leaks, note and/or repair as necessary.
- Check exhaust for tightness and leaks, make necessary repairs.
- Check heater(s) and battery charger.
- Check belts for proper tension

Safety Switch Checks

- Start unit in manual position and perform static test on LOP, HWT, by switching terminal to ground until shutdown occurs. May take up to 20 seconds on LOP.
- Now restart unit again to test over-speed safety. Run engine speed slowly until shutdown occurs. Use speed adjust pot on electronic governors. Note: Do not pull throttle open fast. This could cause damage to unit. Speed must be raised slowly.
- Overcrank test: With unit in the off position, disconnect start solenoid wire #3 on engine controls. Then put switch in manual position. This will initiate start. After the programmed time, the over-crank light will come on. Times are as follows: One shot time – 45 seconds; Cycle crank time – 10 seconds crank, 10 seconds rest, total of 5 cycles. Reconnect wire and start unit to be sure unit is again fully operational. Stop unit. Put unit switch in automatic.
- Check existing generator is connected to ATS with both power and control.

Load Bank Test

- After pre-start checks are completed, load bank(s) can be connected to new generator preferably at the mainline breaker on gen-set. Provide sufficient load banks to match the output Kw rating of the generator and burn generator in for 4 hours.

Signature_____Date_____

Automatic Transfer Switch

Authorized Technician Name_____

ATS No. _____ Priority No. ____ Sub Priority No. ____ Cat. No._____ _____ Load _____ S.O.No._____ Location _____

Switch Type: __ ATS __ ATS/ Bypass __ w/ Acc.28 (Overlapping Neutral)

Pre- Operational Checks :

- Visual Inspection: Inspect and verify the following prior to Energizing any power source to the switch.
- Power termination's completed and properly dressed. __ YES __ NO
- Manually operate the ATS using the manual transfer handle to verify that the Barriers have been properly reinstalled. __ATS __ YES __ NO __ Bypass Sw. __ YES __ NO Important Note: If the ATS switch barriers are not properly re-installed, they can cause the switch to bind up during a transfer and cause severe damage to the switch and controls.
- Control termination's completed and properly dressed. __ YES __ NO
- Cabinet has been Cleaned of all construction dust and debris. __ YES __ NO
- Proper clearance has been maintained for maintenance. __ YES __ NO
- All cabinet hardware and mechanical fasteners installed. __ YES __ NO
- Switch Identification Nameplate installed. __ YES __ NO
- Optional- Communications equipment and termination's completed and properly dressed. __ YES __ NO
- Phase rotation: Normal source __ CW__CCW, Emergency source __CW__ CCW

Operational Checkout: Normal and Emergency power must be available to verify the following.

- Status Indications:__ Feat. 9A (ATS connected to Normal) __ YES __ NO
- Feat. 9B (ATS connected to Emergency) __ YES __ NO
- Feat. 9C (Normal Source available) __ YES __ NO
- Feat. 9D (Emergency Source available) __ YES __ NO
- Feat. 5 (Test Switch) __ YES __ NO
- Feat. 6B (Reset to Normal) __ YES __ NO
- Feat. 17 (Area Protection) __ YES __ NO
- Feat. 30B (Load Shed Controls) __ YES __ NO
- Feat. 30BL (ATS Load Shed Active Indication) __ YES __ NO
- ATS/Bypass Status Indications: Optional
- Bypass connected to Normal __ YES __ NO
- Bypass connected to Emergency __ YES __ NO
- Normal Source available __ YES __ NO
- Emergency Source available __ YES __ NO
- ATS connected to Normal __ YES __ NO
- ATS connected to Emergency __ YES __ NO
- ATS Disconnected __ YES __ NO
- ATS in TEST position __ YES __ NO
- ATS Connected __ YES __ NO

- ☐ Existing generator control and power is connected YES____NO____

Functional ATS Tests

- ☐ ATS Transfer Tests - __ Normal to Emergency
- ☐ Emergency to Normal

Functional ATS/Bypass/Isolation switch Tests. The following Bypass Switch transfer tests will be performed with the ATS DISCONNECTED.

- ☐ Bypass Switch Transfer Tests - __ Auto to Normal
- ☐ Normal to Auto to Emergency
- ☐ Emergency to Auto to Normal
- ☐ Normal to Auto

The following Automatic Transfer Switch tests will be performed with the ATS in the TEST position.

- ☐ ATS Transfer Tests - Normal to Emergency
- ☐ Emergency to Normal

The following Automatic Transfer Switch tests will be performed with the ATS in the CONNECTED position.

- ☐ ATS Transfer Tests - Normal to Emergency
- ☐ Emergency to Normal
- ☐ ATS Load Shed Tests - Shed ATS to Normal (No Normal Power available)
- ☐ Bypass ATS to Emergency

The following Automatic Transfer Switch tests will be performed with the ATS in the CONNECTED position.

- ☐ Simulate Generator and ATS failures to trigger automatic emails and texts to designated Client, Generator, and ATS personnel.

Punch list Items:

_____

_____

_____

Signature_____Date_____

SECTION 26 09 33

ARCHITECTURAL LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work of this section.

B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Provide and install dimming lighting controls as shown on drawings and as described in these Specifications.

B. Provide interface module for each dimming lighting control specified in this Section with the Building Lighting Control System specified in Section 26 09 43.

C. Provide all lighting controls as shown, completely wired, operative and securely attached to supports.

D. Where a catalog number and a narrative or pictorial description are provided, the written description shall take precedence and prevail.

E. General Contractor shall provide electrical subcontractor with entire lighting control specification (including illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the lighting controls they will supply.

F. Type of lighting controls shall be as indicated alphanumerically and as specified.

G. Lighting control details shown may be modified by the manufacturer provided all of the following conditions have been met:

1. Lighting control performance is equal or improved;
2. Performance of fixtures connected to lighting control is equal or improved;
3. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
4. Cost to the Owner is reduced or equal.
5. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.3 SUBMITTALS

A. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer. Cut sheets to clearly show all elements to be supplied and all corresponding product data (including dimming range, lamp and ballast compatibility, voltage, faceplate design and finish, accessories, options, all dimensions and any miscellaneous items detailed in the written description of the specification). If a cut sheet shows more than one (1) product, all non- applicable information shall be crossed out.

B. For standard cataloged lighting controls submit a complete list of materials, including catalog or part numbers, load schedule, address description, function and location.

C. For custom lighting controls submit a reproducible shop drawing prepared by the manufacturer and drawn to scale. Shop drawing to include the name and location of the project. Indicate all corresponding product data including all elements to be supplied, dimming range, lamp and ballast compatibility, voltage, faceplate design and finish, accessories, options, all dimensions and any miscellaneous items detailed in the written description of the specification.

D. For all submittals under paragraphs A through C above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and lighting control type clearly shown.

E. Lighting control cuts and shop drawings shall be submitted in quantities and formats as described in the General Conditions Section of these Specifications.

F. The Engineer and Architect shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the lighting control cut is insufficient.

1.4 SUBSTITUTIONS

A. Bidders' attention is called to the following procedure to be followed in submitting alternate lighting control manufacturers to those specified:

1. Request for approval shall be accompanied by working lighting control samples (with appropriate mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by these Specifications. The above data shall be delivered separately to the Architect and Engineer. The samples may be required to be furnished and installed, at the bidder's expense, at a location selected by the Architect. In addition, the bidder shall furnish the Architect and the Engineer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least one year (12) months, as well as the names and addresses of the Owner, the Architect and the Lighting Designer.

1.5 QUALITY ASSURANCE

A. All lighting controls and assembled components shall be new, of good quality, and be approved by and bear the label of UL or other approved testing agency (i.e. CSA, ETL) unless otherwise specified in writing.

B. All lighting controls shall meet all required local, state and/or national building, electrical and energy codes and regulations.

1.6 CUSTOMER SUPPORT SERVICES

A. Commissioning: The manufacturer shall supply factory-trained representatives to commission the lighting control system. They shall verify that the contractor has properly installed and interconnected all supplied components. They shall start up all equipment and demonstrate that it meets the requirements of this specification.

B. Training: As part of the commissioning procedures, the manufacturer shall train the owner’s representatives in the operation of the system.

C. Technical Support: The manufacturer shall supply telephone support at no additional cost to the owner for the duration of the warranty period.

D. Replacement components: The manufacturer shall be able to ship replacement parts within 24 hours for any component that fails during the warranty period.

E. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.

1.7 WARRANTIES

A. All lighting controls, including parts and workmanship, shall have a warranty of a minimum of one year after the acceptance of the project by the Owner. Any lighting controls found to be defective during the warranty period will be repaired or replaced at no cost to the Owner.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver lighting control equipment and components in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Acceptable manufacturer: Lutron, etc. or approved equal.

B. Manufacturer's Qualifications: The basis of design is Lutron Grafic Eye 4000 series. Similar systems from other manufacturers that meet the functional and performance requirements listed herein will be considered. A detailed line-by-line compliance comparison shall be submitted for the Engineer's review of any alternate system. It is the sole responsibility of the Electrical contractor to ensure that all equipment meets the specifications.

C. Lighting controls shall be fully compatible with all specified fixtures, lamps, transformers and ballasts.

D. Unless otherwise specified, all lighting controls shall be by the same manufacturer.

1. The listing of a manufacture as "acceptable" does not imply automatic approval. It is the responsibility of the Contractor to ensure that any price quotations received and submittals are made for devices that meet or exceed these Specifications.

E. Lighting controls shall operate at the voltage shown in the LIGHTING FIXTURE SCHEDULE and confirmed on the electrical drawings.

F. Dimmers and preset dimming lighting controls shall operate the following sources/load types with a smooth continuous Square Law dimming curve. Dimmers shall also be capable of operating these sources on a non-dim basis. Dimmers shall be electronically assigned to the appropriate load type/dimming curve and can be reassigned at any time. Universal-type dimmers that do not adjust the dimming curve shall not be acceptable.

1. Incandescent, Tungsten and Magnetic Low Voltage Transformer
   a. Dimmer shall contain circuitry specifically designed to control and provide a symmetrical AC waveform to the input of magnetic low voltage transformers.
   b. Dimmer shall not cause a magnetic low voltage transformer to operate above the transformer's rated operating current and temperature.
   c. Dimmer shall contain circuitry to control dioded lamps.

2. Electronic Low Voltage Transformer
   a. No flicker or interaction shall occur at any point in the dimming range.
   b. For integral dimming, an interface shall be required.
3. Electronic Fluorescent Dimming Ballast
   a. Dimmer shall be rated to control ballasts for T-12, T-12 high output, T-8, and T-5 lamps as well as T-4 compact lamps. All lamps on the same circuit must have the same current rating (i.e., T-8), but may be different lengths (i.e., 3' and 4'). Ballasts for fluorescent fixtures must be manufactured by Lutron. The dimming performance shall be as specified in the Lighting Fixture Specifications.
4. Neon and Cold-Cathode
   a. Dimmer shall provide the ability to dim lamps down to 10% of full light output when used with normal (low) power factor transformers. Transformers shall be sized per table developed by dimming system manufacturer.
5. Non-Dim/Switched Loads
   a. Non-dim shall be rated to 16A of resistive, tungsten, induction, or capacitive loads. Non-dim shall incorporate an air gap relay to open circuit when load is off.

G. Dimming Panels

1. Panel shall be wall or floor mounted NEMA grade, constructed of sheet steel plates not less than #16 U.S gauge. Contractor shall reinforce wall as required for wall-mounted panels.
2. Panel shall be completely pre-wired by the manufacturer. The contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the contractor shall be permitted.
3. Unless otherwise indicated, panels shall contain branch circuit protection for each dimming module. Branch circuit breakers shall have the following performance characteristics:
   a. Be U.L listed under U.L 489 as molded case circuit breaker for use on lighting circuits.
   b. Contain a visual trip indicator and shall be rated at 10,000 AIC (120V) or 14,000 AIC (277V), unless otherwise noted.
   c. Be thermal-magnetic in construction for both overload and dead short protection. The use of fully magnetic breakers shall not be acceptable, even when used in conjunction with individual dimmer thermal cutouts.
   d. Be switched duty (SWD) rated so that the loads can be switched off via the breaker.
4. Panel shall be shipped with each dimmer in a BYPASS position via a jumper bar inserted between the input and load terminals. These jumpers shall carry the complete load current and shall be reusable at any time.
5. Panels shall be cooled via free-convection, unaided by fans, and capable of continuous operation to all of these Specifications within an ambient temperature range of 0°C (32°F) to 40°C (104°F).
6. Panel shall provide capability to electronically assign each circuit any zone in the dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable.
7. Multiple panels shall be capable of operating in one system, up to a maximum of 32 panels and 768 dimmers. Panels shall have the ability to control individual circuits without controls.
8. For panels fed with normal/emergency feeder, panel shall include electronics to bring all circuits to full on condition upon loss of normal power and subsequent presence of emergency power. Electronics shall switch both the intensity signal and the on/off signal of each dimmer connected to an emergency circuit between the local and a full-on constant drive supply. This type of emergency may be used with either a normal/emergency generator or a constant hot secondary utility feed where the emergency transfer occurs on the line side (upstream) of the dimming panel and requires only a single normal/emergency feeder.
9. Panels shall have the following additional characteristics:
   a. Be designed to prevent any foreign objects from coming into contact with any part of the panel which would be at an elevated temperature, such as the dimmer extrusions or heat fins.
   b. Be designed to provide airflow across the heat sink areas and through the dimmer chassis. Panel sections which provide airflow only across heat sinks shall not be mounted one above another in order to allow for adequate heat dissipation.

H. Dimming Modules

1. One type of modular dimming card shall be used for all sources. Systems requiring different types of modules or modular dimming cards shall not be acceptable.
2. A positive air gap relay shall be employed with each dimmer to ensure that the load circuits are open when the “off” function is selected at a control station. These relays need not be integral to the dimming module but must be integral to the dimming panel. Lighting control manufacturer shall provide necessary control interface(s) as part of the control system.
3. All dimmers shall be voltage regulated so that a nominal change in the voltage shall not cause a perceptible change in output voltage.
4. The silicon thyristors used to control the power furnished to the loads shall be both designed and tested to withstand surges, without impairment to performance, of 6000VA , 3000A (equivalent to near lightning strike) as specified by ANSI/IEEE std. C62.41. Upon request, the manufacturer shall provide a means to demonstrate conformance to this specification using the appropriate surge-generation equipment.
5. Under full-load conditions in a 40°C environment, all silicon thyristors shall operate at minimum 20°C safely margin below the component temperature rating.
6. Filtering shall be provided in each circuit so that the current rise time shall be at least 400 μsec at 50% rated dimmer capacity as measured from 10-90% of the load current waveform at a 90° conduction angle, and at no point rise faster than 30mA/μsec. Manufacturers should note that additional filters may be required to meet this specification. These filters need not be integral to the dimming module, but must be integral to the dimming cabinet.
7. Dimmer output voltage shall be a minimum 95% of input voltage at maximum intensity setting.
8. Minimum and maximum light levels shall be user adjustable for each dimmer.

I. Integral Dimming

1. Preset dimming controls shall be capable of operating at rated capacity without adversely affecting design lifetime.
2. Preset dimming controls shall mount individually in standard 2, 3, or 4-gang U.S wall boxes.
3. Preset dimming controls shall operate in an ambient temperature range of 0°C (32°F) to 40°C (104°F).
4. Preset dimming controls shall incorporate an airgap switch, which shall be accessible without removing faceplate. The airgap switch shall be capable of meeting applicable requirements of UL 20 for airgap switches in incandescent dimmers.
5. Preset dimming controls shall meet IEC 801-2, tested to withstand 15kV electrostatic discharge without damage or loss of memory.
6. Preset dimming controls shall meet ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges up to 200A without damage.
7. Preset dimming controls shall meet the UL 20 limited short circuit test requirement for snap switches.
8. Preset dimming controls shall be voltage regulated.
9. Preset dimming controls shall utilize an LC filtering network to minimize interference with properly installed radio, audio, and video equipment.
10. Minimum light levels shall be user adjustable in order to compensate for different sources and loading.
11. Separate power booster/interface(s) shall increase dimmer capacity. Capacity shall range from 1000W/VA to 30,000W/VA. Quantities and size of each type of power booster shall be provided to control each type of load shown on the load schedule and/or the drawings.

J. Wall Box Dimmers

1. All devices shall be UL listed specifically for the required loads (i.e., incandescent, fluorescent, low voltage, electronic low voltage). Manufacturer shall provide file card upon request. Universal dimmers shall not be acceptable.
2. Manufacturer shall maintain ISO 9001 certification. Provide a copy of the certificate as part of the submittal.

3. All dimmers and switches shall incorporate an air gap which shall be accessible without removing the faceplate. The air gap switch shall be capable of meeting all applicable requirements of UL 20 and UL 1472 for air gap switches in incandescent dimmers.
4. All dimmers and switches shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
5. Dimmers and switches shall meet ANSI/IEEE Std.C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
6. Dimmers and switches shall meet the UL 20 and UL 1472 limited short circuit test requirement for snap switches.
7. Dimmer control shall be linear slide. Dimmer shall provide a smooth and continuous Square Law dimming curve.
8. Dimmer shall be voltage regulated so that +10% variation in line voltage shall cause not more than a +5% variation in load voltage when dimmer is operating at 40V (5% light output).
9. Dimmers shall utilize a LC filtering network to minimize interference with properly installed radio, audio, and video equipment.
10. Dimmer control slider shall be captured.
11. Faceplate shall snap on to device with no visible means of attachment. Heat-fins shall not be visible on front of device. At locations with multiple devices, one seamless, multi-gang faceplate shall be provided. Contractor is responsible for coordination of proper back box size and faceplate type.

K. Four Scene Preset Control

1. Controls shall provide access to 4 preset lighting scenes and off for up to 8 control zones. Control shall be capable of storing an additional 12 preset lighting scenes. Scenes shall be changeable as required. Up to 8 controls may be tied together for more than 8 zones. Controls shall incorporate built-in wide angle infrared receiver, providing control via a separate a separate infrared wireless remote control transmitter from up to 50 feet away. Preset shall be set via easy-to-use raise/lower switches, one raise and lower switch per zone. The intensity for each zone shall be indicated via an illuminated bargraph Programming of preset scenes shall be accomplished without the use of an ENTER or STORE button. One or more zones may be temporarily overridden without altering the scene values which are stored in memory. Lighting levels shall fade smoothly between scenes at time intervals of 0-59 seconds or 1 to 60 minutes. The fade time shall be separately selectable for each scene. Additionally, control shall provide power failure memory for ten years.
2. Manufacturer shall maintain ISO 9001 certification. Provide a copy of the certificate as part of the submittal.

L. Accessory Control Options

Provide the following controls for use with the preset control(s) as shown on the drawings and/or described in LIGHTING CONTROL DESCRIPTIONS:

1. Two Scene Entrance Control(s) shall be capable of recalling Scene One plus Off, Scenes 7 and 8, or Scenes 13 and 14. Also can be used as raise/lower partition control and Lockout. All above based on dipswitch settings.
2. Four Scene Control(s) shall be capable of recalling any one of four scenes, master raise/lower, and Off. Control shall provide access to up to 16 scenes.
3. Fine Tuning Control(s) shall allow the temporary override of a particular zone or zones from the preset light level.
4. Infrared Wireless Transmitter(s) shall be capable of recalling any one of four preset scenes and Off. In addition, a master raise/lower shall be provided. The transmitter shall be manufactured by the dimming system manufacturer. The range of the transmitter to any single receiver shall be at least 50 feet. Wall receiver shall incorporate buttons for four scene select, master raise/lower, and off. Ceiling receiver shall provide 360° view and an integral LED to provide feedback of proper infrared signal.

5. Special Function Control(s) shall provide the following functions:
   a. Sequencing shall allow the user to set up and operate a sequence of 4, 12, or 60 steps. A sequence shall be defined as a series of steps, while a step shall be defined as the recall of a scene. Each step interval is adjustable from 1 second to 60 minutes.
   b. Zone lockout shall allow temporary changes without altering light levels preset for each scene.
   c. Scene lockout shall lockout the control, maintaining current scene and disabling all buttons on the preset dimming controls.
   d. Fade override shall set all fade times to zero.
6. Partition Control(s) shall provide two or four buttons for operating multiple preset units independently or in combination. Each button shall have a corresponding LED to indicate status of a specific partition "door."
7. Photocell Interface Control(s) shall provide scene selection via daylight photosensor.
8. Equipment Interface(s) shall allow access to preset dimming control(s) via one of the following methods:
   a. Isolated momentary/maintained dry contact closures. Where indicated on the drawings, each interface shall provide isolated maintained contact closures rated at 200mA at 30VDC for pilot light status feedback.
   b. For use with four scene preset control, RS232 serial communication.
   c. For use with four scene preset control, astronomic time clock with 60 events/day and 4 schedules.
   d. For use with multiple area-centralized control, DMX512 interface with control of 32 continuous dimming zones via external DMX512 device.

M. Wiring of lighting controls shall comply with all applicable Sections of these Specifications, as well as manufacturer's specifications and local, state and/or national building, electrical and energy codes and regulations.

N. Equipment shall not use analog technology for communication.

O. Equipment shall be manufactured using surface mount technology.

PART 3 - EXECUTION

3.1 LOCATION

A. Locations of lighting controls are shown diagrammatically. Verify exact location and spacing with Plans, Sections and other reference data before ordering of lighting controls and during installation.

B. Notify Architect about field conditions at variance with Contract Documents before commencing installation.

C. Coordinate space conditions with other trades before ordering of lighting controls.

3.2 INSTALLATION

A. Wiring from dimming panel to preset dimming control and accessory controls shall be low voltage Class 2 wiring. All lighting control wiring shall be in an approved raceway specified in Section 26 05 33.

B. Provide accessories as required for construction type indicated on Finish Schedule. Lighting control catalog numbers do not necessarily denote specific mounting accessories for type of wall or surface in which a lighting control may be installed.

C. Provide adequate and sturdy support for each lighting control component. Contractor shall be responsible for verifying weight and mounting method of all lighting controls and furnishing and installing suitable supports. Lighting control mounting assemblies shall comply with all local codes and regulations.

D. Contractor shall be responsible for mounting the lighting controls at the proper depth, and for coordinating the cutout size and shape in wall to ensure that the faceplate covers the cutout entirely. Refer to drawings for location and mounting height of controls.

E. Install lighting controls with vent holes free of air-blocking obstacles.

F. Support elements shall not be mounted to or in contact with ducts or pipes.

G. Mask the lighting controls as necessary to protect the controls during construction.

H. At the completion of construction, clean the face plates and exposed surfaces of all lighting controls, so as to render them free of any material, substance or film foreign to the lighting control. Use soft, non-abrasive cloth and a cleaning solution recommended by the lighting control manufacturer. If the lighting controls are deemed dirty by the Architect at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Lighting control components whose finishes are damaged shall be replaced at no cost to the Owner.

I. Contractor shall furnish all equipment, labor and materials for the proper installation and system setup of all lighting controls and components as shown on drawings and as specified. System setup includes defining each dimmer's load type, assigning each load to a zone, and setting the control functions. System setup shall take place before building is turned over to Owner, after regular working hours where required.

3.3 FIELD SUPPORT

A. Upon completion of installation, the Manufacturer shall provide a qualified field technician to make one (1) visit to the project site for 5 days to assist the Contractor in commissioning the control system. Manufacturer to be capable of providing on-site service support within 24 hours anywhere in the continental U.S.A., and within five business days anywhere in the world, except where special visas are required.

B. A local factory-trained technician within 50 miles of the project is required. Spare parts should be stocked locally.

END OF SECTION

SECTION 260943 - Digital-Network Lighting Controls

PART 1 – GENERAL

1.1 SUMMARY

1.1 Section Includes:

1. Networked Central Lighting Control systems. Systems are composed of:
    a. Network integrated power switching systems.
    b. Network integrated dimming systems.
    c. Standalone power switching and dimming systems.
    d. Automation control processors.
    e. Sensors
    f. User Interfaces:
        1) Keypad
        2) Touch screen
        3) Virtual touch screen
2. System Functions and Sequences

A. Related Requirements:

1. Section 12 24 13 Roller Window Shades
2. Section 25 08 00 Commissioning of Integrated Automation
3. Section 25 10 00 Integrated Automation Network Equipment
4. Section 25 11 13 Integrated Automation Network Servers
5. Section 25 13 13 Integrated Automation Control and Monitoring Network Supervisory Control
6. Section 25 13 19 Integrated Automation Control and Monitoring Network Interoperability
7. Section 25 15 16 Integrated Automation Software for Control and Monitoring Networks
8. Section 26 05 00 Common Work Results for Electrical
9. Section 26 27 26 Wiring Devices
10. Section 26 51 00 Interior Lighting
11. Section 27 15 00 Communications Horizontal Cabling
12. Section 27 41 00 Audio-Video Systems

1.2 REFERENCES

A. Definitions

1. Control: Effecting a change in state by one PC program onto a microprocessor or device.
2. Scene: Predetermined light level of a single fixture of group of fixtures.
3. DALI: Digital addressable lighting interface.
4. RS-485: A serial network protocol complying with TIA-485-A.
5. UTP: Unshielded twisted pair.

B. Reference Standards

1. California Energy Commission (CEC):
2. CEC CCR Title 24, Part 6: California Energy Efficiency Standards for Residential and Nonresidential Buildings, California's Appliance Energy Efficiency program: Listed for lighting control devices.
3. National Fire Protection Association (NFPA):
4. NFPA 70 - National Electrical Code.
5. Underwriters Laboratories (UL)
   a. UL 508 – Industrial Control Equipment.
   b. UL924 – Emergency Lighting and power Equipment.
   c. UL1008 – Transfer Switch Equipment.

1.3 REQUIREMENTS

A. Coordination

1. Contractor shall place daylight and occupancy sensors per plans to achieve optimal performance. Proper placement shall be coordinated with others in order to avoid interference with prescribed lighting levels.
2. Contractor shall provide luminaries and lamps that are compatible with the lighting control system to be installed.
3. Contractor shall locate touch screen and keypad stations as per plans.
4. Contractor shall notify engineer of record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.4 SYSTEM DESCRIPTION

A. Web Accessible, network connected, lighting control system utilizing preset control software, central signal microprocessor, lighting control panel including integrated branch circuit protection, and [power switching modules and relays] [Dimming Modules] [DALI Control Modules] [Sensors User Interfaces].

B. System Components: System includes the following addressable components:

1. Keypad controls.
2. Touch screen controls.
3. Window treatment controls.

4. Remote occupancy sensors.

5. Lighting load shedding.

6. Timed room lighting.

7. Daylight compensating lighting controls.

8. Communication interface to facility-wide room management system.

9. Communication interface to building automation system gateway/interface.

1.5 SUBMITTALS

A. Product Data: For each type of product required for complete network lighting control system, demonstrating compliance with requirements.

B. Shop Drawings: Indicated the following:

1. Schematic diagram showing complete network lighting control system and accessories.

2. Circuits and emergency circuits with capacity and phase, control zones, load type and voltage per circuit.

1.6 CLOSEOUT SUBMITTALS

A. Operating and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualification: Manufacturer of network lighting controls with minimum [five] years record of satisfactory manufacturing and support of components comparable to basis of design system.

B. Source Requirements: Provide Network Lighting System through a single source from a single manufacturer.

C. Manufacturer Qualifications: Approved manufacturer of network lighting controls listed in this Section with minimum [five] years record of satisfactory manufacturing and support of components comparable to basis of design system.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

a. Product data, including certified independent test data indicating compliance with requirements.

b. Samples of each component.

c. Sample submittal from similar project.

d. Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.

e. Sample warranty.

2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.

D. Approved manufacturers must comply with separate requirements of Submittals Article.

E. Electrical Components, Devices, and Accessories: UL listed and labeled per NFPA 70.

F. California Appliance Efficiency Listing: Provide products that comply with provisions of CEC CCR Title 24, Part 6.

1.8 COORDINATION

A. Coordinate integrated lighting and dimming controls with systems and components specified in the following sections:

1. Division 11 Section "Audio-Visual Equipment".
2. Division 12 Section "Window Treatments".
3. Division 23 Section "Instrumentation and Control for HVAC".
4. Division 25 Section "Integrated Automation Control of Electrical Systems".
5. Division 26 Section "Panelboards".
6. Division 26 Section "Wiring Devices".
7. Division 26 Section "Lighting Devices".
8. Division 26 Section "Interior Lighting".
9. Division 27 Section "Communications Horizontal Cabling".
10. Division 27 Section “Audio-Video Systems”
11. Division 28 Section "Electronic Access Control and Intrusion Detection".

1.9 PROJECT CONDITIONS

A. Environmental Conditions Range:

1. Temperature: 32 – 104 deg F (0 - 40 deg C).
2. Relative Humidity: 10 – 90 percent, noncondensing.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of modular dimming controls system the fail in materials or workmanship within the specified warranty period following substantial completion.

1. Warranty Period: Commercial lighting dimmers and switches, sensors, keypads, lighting enclosures, terminal blocks, power supplies, thermostats, and control processors, when dedicated for use as part of a commercial lighting control system: 5 year warranty
2. Manufacturer's Extended Support Service: Extended telephone support: Unlimited period.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following Manufacturers:

1. Crestron Electronics INC.

2. [XXXXXXXX]

3. [XXXXXXXX]

B. Substitutions:

1. All substitutions must be submitted in writing to the Engineer of Record within [14] days prior to bid date.

2. Proposed substitutions must be documented with a compliance review.

2.2 GENERAL

A. Contractor shall provide system hardware that is manufactured and warranted by a single manufacturer.

B. Provide control system with compatibility for BACNET/IP.

C. System shall provide time clock functionality as well as support for multiple interface devices.

D. System must automatically adjust for daylight savings time and leap year.

2.3 ZUM WIRED DIMMING SOLUTIONS

A. Load Controllers

1. ZUMNET-Junction Box Zone Controllers

a. Junction box mounted using ½" knockout.

b. 120/277 VAC input

c. Real-time Power monitoring

d. Connections

1) ZUMLINK RJ45 ports x 2 (Cresnet)

2) ZUMNET RJ45 ports x 2 (Ethernet)

3) Occ Sensor Input (24V, G, OCC)

4) Photo Sensor Input (24V, G, PHO)

5) Override Input (OVR, G)

6) Integrated Ethernet Switch allowing daisy chaining (up to 20 devices)

e. Products:

1) CRESTRON ZUMNET-JBOX-16A-LV (16A, 0-10V)

2) CRESTRON ZUMNET-JBOX-16A-DALI (16A, 1 DALI LOOP)

2. ZUMLINK-Junction Box Zone Controllers

a. Junction box mounted using ½" knockout.

b. 120/277 VAC input

c. Real-time Power monitoring

d. Connections

1) ZUMLINK RJ45 ports x 2 (Cresnet)

2) Occ Sensor Input (24V, G, OCC)

3) Photo Sensor Input (24V, G, PHO)

4) Override Input (OVR, G)

e. Products:

1) CRESTRON ZUMLINK-JBOX-16A-LV (16A, 0-10V)

2) CRESTRON ZUMLINK-JBOX-20A-SW (20A, SWITCHED)

3) CRESTRON ZUMLINK-JBOX-20A-PLUG (20A, SWITCHED PLUG LOAD)

4) CRESTRON ZUMLINK-JBOX-DIMU. (5A UNIVERSAL PHASE DIMMING)

B. User Interfaces

1. ZUMLINK-keypads

a. Field configurable remote keypad , engravable programmable buttons in number indicated, with Single Green LED indicator, configured to fit in standard single-gang box.

b. Trimmed using decorator style faceplate (not included) or Crestron decorator-style faceplates (FP-G series)

c. RJ45 connection for power and communication (2 x RJ45 ZUMLINK ports facing up)

d. Bluetooth connectivity

e. Minimum Buttons: 2, Maximum Buttons:8.

f. Color shall be White

g. Mounting: Mounts in a 1-gang or larger electrical box or mud ring

h. Products

1) ZUMLINK-KP

2) ZUMLINK-KP-GOV

a) No Bluetooth

2. ZUMLINK-WAP

a. Wireless Access Point for ZUMMESH system integration

b. Mounting: Mounts in a 1-gang box.

c. RJ45 connection for power and communication (2 x RJ45 ZUMLINK ports)

d. Supports integration of ZUMMESH wireless communication products using a Wi-Fi friendly 2.4 GHz peer-to-peer mesh network topology.

e. Supports integration of 6 zummesh battery devices and 20 AC powered devices

3. ZUMLINK-IO

a. Control Port Expansion Module

1) 4 x Contact Closure Inputs

2) 2 x Contact Closure Outputs

3) Bi-directional RS232 for room control

b. RJ45 ZUMLINK connection for power and communication (2 x RJ45 ZUMLINK ports)

c. Product: ZUMLINK-IO

4. ZUMLINK-PART

a. Partition Sensor Integration Module

b. Accepts signal from GLS-PART-CN Partition Sensor

c. RJ45 connection for power and communication (4 x RJ45 ZUMLINK ports)

d. Product: ZUMLINK-PART

C. Networking the wired Spaces

1. Zumwired spaces shall be networked together to enable time clock, load shedding and global management features.

2. The space shall be networked using a ZUMNET RJ45 ports (Ethernet)

3. Networking the space shall incorporate BMS integration as specified hereto after.

D. Devices

1. Floor Hub

a. Connects up to 1000 Rooms connected via ZUMNET.

b. Contains astronomical time clock.

c. Maintenance is performed via standard web browser.

d. 1 rack unit mounted

Product: Crestron ZUM-FLOOR-HUB

2.4 ZUM WIRELESS DIMMING SOLUTIONS

A. Wireless technology shall be fully compatible and scalable with all manufacturer lighting control solutions

B. All batteries shall be field replaceable with non-proprietary standard sizes

C. Wireless device characteristics

1. Lighting control devices shall communicate using a Wi-Fi friendly 2.4 GHz peer-to-peer mesh network topology.

2. Devices shall be commissionable as an autonomous control system without the need for additional equipment.

3. Each device shall auto negotiate its RF channel to avoid noisy commercial environments.

4. Shall be secured using 128-bit encryption.

5. Up to 32 devices can make up a space.

6. The range within wireless devices shall be 50'.

D. Devices

1. Junction Box Zone Controllers

a. ZUMMESH Wireless Communication.

b. Junction box mounted using ½" knockout.

c. 120/277 VAC input

d. Products:

1) Crestron ZUMMESH-JBOX-16A-SW (16A, SWITCHED)

2) CRESTRON ZUMMESH-JBOX-5A-LV (5A, 0-10V)

3) CRESTRON ZUMMESH-JBOX-16A-LV (16A, 0-10V)

4) CRESTRON ZUMMESH-JBOX-20A-PLUG (20A, SWITCHED PLUG LOAD)

5) CRESTRON ZUMMESH-JBOX-DALI-1. (1 DALI LOOP)

6) CRESTRON ZUMMESH-EXP-JBOX-16A-DIMU. (16A UNIVERSAL PHASE DIMMING)

2. Wall Box Zone Controllers

a. ZUMMESH Wireless Communication

b. Trimmed using gangable decorator trim plates

c. Mounted in 3.5" back box.

d. Color shall be white [black] [Almond]

e. Products:

1) Crestron ZUMMESH-5A-SW-W-[B][A] - S (switched load, 5A)

2) Crestron ZUMMESH-5A-LV-W-[B][A] - (0-10v dimmed load, 5 amps)

3) Crestron ZUMMESH-DIM-W-[B][A] - (forward phase load, 4 amps)

4) Crestron ZUMMESH-DELV-W-[B][A] - (reverse phase load, 4 amps)

3. Keypads (Battery Powered)

a. ZUMMESH wireless communication

b. Electrical Box, wall, or glass mount

c. Trimmed using gangable decorator trim plates

d. Replaceable coin cell battery (5-year life)

e. Color shall be white [black] [Almond]

f. 1 Button (rocker with ON/OFF/DIM UP/DIM DOWN features)

1) Product: Crestron ZUMMESH-KP10ABATT-W [B][A]-S

g. 4 Button (ON/SCENE 1/SCENE 2/OFF)

1) Product: Crestron ZUMMESH-KP10BBATT-W-[B][A]-S

h. 6 Button (ON/SCENE 1/SCENE 2/OFF/DIM UP/DIM DOWN)

1) Product: Crestron ZUMMESH-KP10CBATT-W-[B][A]-S

i. 6 Button (ON/SCENE 1/SENSOR DISABLE/OFF/DIM UP/ DIM DOWN)

1) Sensor Disable – Lights will not turn off automatically for 2 hours.

2) Product: Crestron ZUMMESH-KP10DBATT-W-[B][A]-S

4. Keypads (AC Powered)

a. ZUMMESH wireless communication

b. Electrical Box Mountable

c. Trimmed using gangable decorator trim plates

d. 120/277 VAC input

e. Color shall be white [Black][Almond]

f. 1 Button (Rocker with ON/OFF/DIM UP/DIM DOWN features)

1) Product: Crestron ZUMMMESH-KP10A-W-[B][A]-S

g. 4 Button (ON/SCENE 1/SCENE 2/OFF)

1) Product: Crestron ZUMMESH-KP10B-W-[B][A]-S

5. Dual Loop daylight sensors

a. ZUMMESH wireless communication

b. Uses open and closed loop technologies for auto calibration

c. Open loop sensing technology for daily sensing

d. Replaceable (2) lithium-ion AAA batteries (10-yr life)

e. Product: Crestron ZUMMESH-PHOTOCELL-BATT

6. Motion Sensors

a. ZUMMESH wireless communication

b. Passive infrared sensing technology

c. Ceiling Mounted

d. 500 SQFT. Coverage (8-12 ft. ceilings)

e. Grace Occupancy – When lights turn off due to vacancy, a 15-second grace period starts during which the room lights can be turned on again by waving a hand to trigger the sensors.

f. Vacancy sensors shall go to occupancy mode when keypad low battery detected.

g. Replaceable lithium-ion 9V battery (10-Year life)

h. Products:

1) Crestron ZUMMESH-PIR-OCCUPANCY-BATT (auto on, auto off)

2) Crestron ZUMMESH-PIR-VACANCY-BATT (manual on, auto off)

7. Partition Sensor

a. ZUMMESH wireless communication

b. 24 VDC Input

c. Sensor Technology: Diffuse reflective

d. Light Source: Pulse modulated infrared LED

e. Mounts in a 1-gang US electrical box

f. Product: ZUMMESH-PART

8. Sensor Interface Device

a. ZUMMESH wireless communication

b. Junction box mounted using ½" knockout

c. 120/277 VAC Input

d. Supplies 24 VDC, 250MA to connected sensors wired in parallel

e. Product: ZUMMESH-JBOX-SIM

E. Networking the Wireless Spaces

1. Wireless spaces shall be networked together to enable time clock, load shedding and global management features.

2. The space shall be networked using a Wi-Fi friendly 2.4 GHz mesh network topology.

3. The range between the wireless devices shall be no more than 150'

4. The wireless technology shall be Crestron zūm Net.

5. Networking the space shall incorporate BMS integration as specified hereto after.

6. Wireless solutions shall be fully compatible with all other lighting control solutions specified herein.

F. Devices

1. Wireless Bridge

a. Each space shall have minimum one wireless bridge that links the space with the network connection.

b. Wireless bridge shall enable IOS or Android app to configure space using Bluetooth technology.

c. Crestron Zūm wireless bridge shall have communication with up to 32 MESH devices.

d. Product: ZUMMESH-NETBRIDGE

2. Wireless Gateway

a. Crestron Zūm NET gateway shall have bi-directional MESH communication with up to 50 ZUMMESH-NETBRIDGE devices.

b. Powered via IEEE 802.3 at Type 1.

c. Product: Crestron ZUMNET-GATEWAY

3. Floor Hub

a. Connects up to 1000 Crestron ZUMMESH-NETBRIDGE devices.

b. Contains astronomical time clock.

c. Maintenance is performed via standard web browser.

d. 1 rack unit mounted

e. Product: Crestron ZUM-FLOOR-HUB

2.5 WIRED LOAD CONTROLLERS

A. Product Family: Crestron Spacebuilder GLPP

1. Characteristics:

a. Provide 1, 2, or 3 zone lighting controllers for 0-10v zones.

b. Shall operate as an autonomous lighting controller for the space.

c. All sensors and zones within the space shall be controlled without additional equipment.

d. Lighting controller shall be surface-mounted. Industrial control enclosure mounts directly on two side by side 4” square electrical junction boxes, suitable for concealed locations.

e. Circuit Input: 100 – 277 VAC, 50/60 Hz. Input, one 16 amp.

f. [Lighting controller shall be networked as part of the building wide lighting control system using Cresnet communication]

2. Zone Outputs

g. 1,2, or 3 high inrush mechanically held relays for switching loads.

h. 1,000,000 cycle mechanically latching relays

i. Zero-cross arc-less high inrush

j. Air gap off protection on each channel

k. 0-10v dimming models shall include 0-10v 4 wire dimming for each channel.

3. Products

a. Crestron GLPP-SWCN (1 Zone Switching)

b. Crestron GLPP-1SW2CN (2 Zone switching)

c. Crestron GLPP-1SW3CN (3 Zone switching)

d. Crestron GLPP-DIMFLVCN-PM (1 ZONE 0-10v with Power Monitoring)

e. Crestron GLPP-1DIMFLV2CN-PM (2 ZONE 0-10v with Power Monitoring)

f. Crestron GLPP-1DIMFLV3CN-PM (3 ZONE 0-10v with Power Monitoring)

B. Product Family: Crestron GLPAC

1. Characteristics

a. Provide 4 or 8 zone lighting controller for switching or 0-10v zones.

b. Unit shall operate as an autonomous lighting controller for the space.

c. Up to 4 occupancy sensors and photocells per space

d. Up to 10 devices can connect without additional power

e. [Lighting controller shall be networked as part of the building wide lighting control system using ethernet communication]

f. Lighting controller shall be a surface-mounted NEMA 1 industrial control enclosure, suitable for concealed locations.

2. Zone Outputs

a. 4 or 8 circuit inputs

b. 100 – 277 VAC, 50/60 HZ. 16amps each.

c. [Barriered 4 normal and 4 emergency relays (-4E models only)]

d. 4 or 8 zone outputs

e. 100,000 cycle mechanically latching relays

f. Air gap off protection on each channel.

g. 0-10v 4-wire dimming for each channel (60mA max current sink)

h. Override port for UL924 life safety applications

i. [Real time power monitoring on all channels (-PM models only)]

j. [4 normally open isolated relays (-PM models only)]

k. [Chicago Plenum rated enclosure (-CP models only)]

3. Products

a. Crestron GLPAC-DIMFLV4 [-CP] [-PM] (4-CH controller)

b. Crestron GLPAC-DIMFLV8 [-CP] [-PM] (8-CH controller)

c. Crestron GLPAC-DIMFLV8-4E [-CP] [-PM] (4-ch NORMAL & 4-ch emergency controller)

C. Product Family: CAEN, CAEN MLO

1. Characteristics

a. Panel shall be digitally addressable using serial or Ethernet communication from Control Processor Panel specified here to after.

b. Lighting dimmers shall be compatible with drivers / ballasts and LEDs / lamps as listed in SS26 50 00 LIGHTING.

c. Dimmers shall be provided in quantities, control types, and rated for the connected load as shown on the Contract Drawings.

d. Line and load phases shall be coordinated per manufacturers recommendations.

e. Dimming modules shall be field replaceable.

f. Dimming panels shall be listed to UL508.

g. Emergency Override: Remote override capability.

h. Microprocessor based control for time clock override and remote dimming.

i. Lighting control panels shall comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

j. Panel may contain Crestron 3-Series Control Processor

1) Product: Crestron DIN-AP3

k. Panel may contain 24V power supply

1) Product: Crestron DIN-PWS60

l. Panel may contain ethernet to serial converter

1) Product: Crestron DIN-CENCN-2

2. FEED TYPES

a. Reference contract drawing schedules for required feed types and breaker ratings

b. FEED-THROUGH (FT)

1) No Branch circuit overcurrent protection.

c. Main Lug Only (MLO)

1) 120vac 3-phase; 120/240 VAC split-phase

a) 20 AMP thermal magnetic BREAKER

b) AIC rated to 10,000A

c) 20 breakers max per enclosure.

3. Control Modules

a. GL-CAEN-4HSW4-KIT

1) (4) 16A High Inrush Switching Outputs

2) Arc-less high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.

3) 120V AC, 50/60 Hz.

4) 32 degrees to 104 degrees Fahrenheit

5) UL924 for emergency lighting control.

b. GL-CAEN-2DIMFLV8- [277]-KIT

1) (8) 4A 0-10V LED, fluorescent or switching outputs

2) [120] – [277] V, 50/60Hz.

3) 32 to 104 degrees Fahrenheit

4) UL924 for emergency lighting control.

c. GL-CAEN-2DIMU8-[277]-KIT

1) (8) 4A Forward, Reverse Phase or switching outputs

2) [120] – [277] V, 50/60Hz.

3) 32 to 104 degrees Fahrenheit

4) UL924 for emergency lighting control.

d. CLX-1DIMU4-HP

1) (4) Forward, Reverse Phase or switching outputs.

2) Up to 16A total, 10A Max per output.

3) 120 V, 50/60Hz.

4) 32 to 104 degrees Fahrenheit.

5) UL924 for emergency lighting control.

e. GL-CAEN-2DIM8-[277]-KIT

1) (8) 4A Forward, Reverse Phase or switching outputs

2) [120] – [277] V, 50/60Hz.

3) 32 to 104 degrees Fahrenheit

4) UL924 for emergency lighting control.

f. CLX-1FAN4

1) 4 Fan Control Channels

2) 2 Amps Per Channel

3) Module Total 8 Amps

4) Load Types Ceiling Fan Motors

5) 32 to 104 degrees Fahrenheit

6) 120 Volts AC, 50/60Hz, single-phase

4. Enclosures CAEN-FT

a. CAEN-2x1

1) 16AWG Galvanized steel backbox

2) Height: 23.50 in (596.9 mm)

3) Width: 14.38 in (365.1 mm)

4) Depth: 4.00 in (101.6 mm)

5) 120-277 VAC.

b. CAEN-4x1

1) 16AWG Galvanized steel backbox

2) Height: 38.25 in (971.6 mm)

3) Width: 14.38 in (365.1 mm)

4) Depth: 4.00 in (101.6 mm)

5) 120-277 VAC.

c. CAEN-7x1

1) 16AWG Galvanized steel backbox

2) Height: 62.00 in (1574.8 mm)

3) Width: 14.38 in (365.1 mm)

4) Depth: 4.00 in (101.6 mm)

5) 120-277 VAC.

d. CAEN-4x2

1) 16AWG Galvanized steel backbox

2) Height: 38.25 in (971.6 mm)

3) Width: 25.50 in (647.7 mm)

4) Depth: 4.00 in (101.6 mm)

5) 120-277 VAC.

e. CAEN-7x2

1) 16AWG Galvanized steel backbox

2) Height: 62.00 in (1574.8 mm)

3) Width: 25.50 in (647.7 mm)

4) Depth: 4.00 in (101,6 mm)

5) 120-277 VAC.

5. Enclosures CAEN-MLO

a. CAEN-3x1-MLO-120/3P

1) 16AWG Galvanized steel backbox

2) Height: 39.65 in (1008 mm);

3) Width: 16.10 in (409 mm);

4) Depth: 4.98 in (127 mm)

5) 120/208 AC, 225 Amps MAX.

b. CAEN-5x1-MLO-120/3P

1) 16AWG Galvanized steel backbox

2) Height: 62.75 in (1594 mm);

3) Width: 16.10 in (409 mm);

4) Depth: 4.98 in (127 mm)

5) 120/208 AC, 225 Amps MAX.

c. CAEN-5x2-MLO-120/3P

1) 16AWG Galvanized steel backbox

2) Height: 62.75 in (1594 mm);

3) Width: 27.25 in (693 mm);

4) Depth: 4.98 in (127 mm)

5) 120/208 AC, 225 Amps MAX.

D. Product Family: GLEX-FT, GLEP-MLO

1. Characteristics: GLEX-FT

a. Panel shall be digitally addressable using serial or Ethernet communication from Control Processor Panel specified here to after.

b. Lighting dimmers shall be compatible with drivers / ballasts and LEDs / lamps as listed in SS26 50 00 LIGHTING.

c. Dimmers shall be provided in quantities, control types, and rated for the connected load as shown on the Contract Drawings.

d. Line and load phases shall be coordinated per manufacturers recommendations.

e. Dimming modules shall be field replaceable.

f. Dimming panels shall be listed to UL508.

g. Dimming panels shall be listed to UL924.

h. Emergency Override: Remote override capability.

i. Microprocessor based control for time clock override and remote dimming.

j. Lighting control panels shall comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

k. No Branch circuit overcurrent protection.

l. All SpaceBuilder panels will be UL508 factory assembled.

m. Panels may contain 3-series control processor.

1) Product: Crestron DIN-AP3

n. Panel may contain 24V power supply

1) Product: Crestron DIN-PWS60

o. Panel may contain ethernet to serial converter

1) Product: Crestron DIN-CENCN-2

2. Control Modules

a. GLXP-DIMFLV8-LP

1) (8) 16A 0-10V LED, fluorescent or switching outputs.

2) Arc-less high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.

3) 120-277 VAC, 50/60 Hz.

4) 32 degrees to 104 degrees Fahrenheit

5) UL924 for emergency lighting control.

b. GLXP-SW16-LP

1) (16) 16A switching outputs

2) 120-277 VAC, 50/60 Hz.

3) 32 to 104 degrees Fahrenheit

4) UL924 for emergency lighting control.

5) 500,000 on/off cycles

c. GLXP-HSW12-LP

1) (12) 16A High-Inrush switching outputs.

2) 120-277 VAC, 50/60 Hz.

3) 32 to 104 degrees Fahrenheit

4) Arc-less high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.

5) UL924 for emergency lighting control.

d. GLXX-2DIM8

1) (8) (4A) Forward Phase, 2-wire or switching outputs.

2) 4 channels of 3-wire fluorescent dimming.

3) 120 – 277 VAC, 50/60Hz.

4) 32 to 104 degrees Fahrenheit.

e. GLXX-HDSW8

1) Up to 8 channels of heavy duty modular relays

a) Relays: GLR-HD-1P and GLR-HD-2P

b) Supports 120, 230, 277 & 347 Volt applications

2) Requires 24 Volts DC, delivered via 16 pin GLXX-CTRL

f. GLXX-HDSW16

1) Up to 8 channels of heavy duty modular relays

a) Relays: GLR-HD-1P and GLR-HD-2P

b) Supports 120, 230, 277 & 347 Volt applications

2) Requires 24 Volts DC, delivered via 16 pin GLXX-CTRL

3. Enclosures GLEX-FT

a. GLEX-FT-24

1) 16AWG Galvanized steel backbox. Surface Mount.

2) Height: 124.25 in (616 mm)

3) Width: 16.13 in (409 mm)

4) Depth: 4.44 in (113 mm)

5) 120-277 VAC.

b. GLEX-FT-56

1) 16AWG Galvanized steel backbox

2) Height: 39.66 in (1007 mm)

3) Width: 16.13 in (409 mm)

4) Depth: 4.44 in (113 mm)

5) 120-277 VAC.

c. GLEX-FT-84-HC

1) 16AWG Galvanized steel backbox

2) Height: 63 in (1600.2 mm)

3) Width: 15.25 in (387.35mm)

4) Depth: 4.5 in (114.3 mm)

5) 120-277 VAC.

4. Enclosures GLEP-MLO

a. GLEP-277-30

1) 16AWG Galvanized steel backbox

2) Height: 70 in (1778 mm)

3) Width: 20.25 in (514 mm)

4) Depth: 6.63 in (168 mm)

5) 30 Zone cabinet @ 277V VAC

b. GLEP-120-30

1) 16AWG Galvanized steel backbox

2) Height: 70 in (1778 mm)

3) Width: 20.25 in (514 mm)

4) Depth: 6.63 in (168 mm)

5) 30 Zone cabinet @ 120V VAC

c. GLEP-277-42

1) 16AWG Galvanized steel backbox

2) Height: 78 15/16 in (2005 mm)

3) Width: 20.25 in (514 mm)

4) Depth: 6.63 in (168 mm)

5) 42 Zone cabinet @ 277V VAC

d. GLEP-120-42

1) 16AWG Galvanized steel backbox

2) Height: 78.93 in (2005 mm)

3) Width: 20.25 in (514 mm)

4) Depth: 6.63 in (168 mm)

5) 42 Zone cabinet @ 120V VAC

e. Branch Circuit Breakers

1) 120V/10K AIC

a) 120 VAC 20 AMP

b) Product: GLE/GLEPB-120-20A-10K

2) 120V/22K AIC

a) 120 VAC 20 AMP

b) Product: GLE/GLEPB-120-20A-22K

3) 120V/65K AIC

a) 120 VAC 20 AMP

b) Product: GLE/GLEPB-120-20A-65K

4) 277V/18K AIC

a) 277 VAC 20 AMP

b) Product: GLE/GLEPB-277-20A-18K

5) 277V/35K AIC

a) 277 VAC 20 AMP

b) Product: GLE/GLEPB-277-20A-35K

6) 277V/65K AIC

a) 277 VAC 20 AMP

b) Product: GLE/GLEPB-277-20A-65K

E. Product Family: DIN

1. Characteristics

a. Panel shall be digitally addressable using serial or Ethernet communication from Control Processor Panel specified here to after.

b. Lighting dimmers shall be compatible with drivers / ballasts and LEDs / lamps as listed in SS26 50 00 LIGHTING.

c. Dimmers shall be provided in quantities, control types, and rated for the connected load as shown on the Contract Drawings.

d. Dimming modules shall be field replaceable.

e. Dimming panels shall be listed to UL508.

f. Dimming panels shall be listed to UL924.

g. Emergency Override: Remote override capability.

h. Microprocessor based control for time clock override and remote dimming.

i. Lighting control panels shall comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

j. Panel may contain 3-series control processor.

1) Product: Crestron DIN-AP3

k. Panel may contain 24V power supply

1) Product: Crestron DIN-PWS60

l. Panel may contain serial hub capable of 3 subnets

1) Product: Crestron DIN-HUB

m. Panel may contain ethernet to serial converter

1) Product: Crestron DIN-CENCN-2

n. Cabinet may contain POE Switch

1) Product: CEN-SW-POE-5

F. Enclosures

1. Enclosure Family: DIN-EN

a. DIN-EN-2X18

1) 16AWG Galvanized steel backbox

2) Height: 12.32 in (323 mm)

3) Width: 14.13 in (359 mm)

4) Depth: 4.38 in (111 mm)

5) 120-277 VAC.

6) DIN Rail Detail: (2) 342 mm x 35 mm rails

b. DIN-EN-3X18

1) 16AWG Galvanized steel backbox

2) Height: 23.50 in (597 mm)

3) Width: 14.38 in (366 mm)

4) Depth: 4.44 in (113 mm)

5) 120-277 VAC.

6) DIN Rail Detail: (3) 342 mm x 35 mm rails

c. DIN-EN-6X18

1) 16AWG Galvanized steel backbox

2) Height: 38.88 in (989 mm)

3) Width: 14.38 in (366 mm)

4) Depth: 4.44 in (113 mm)

5) 120-277 VAC.

6) DIN Rail Detail: (6) 342 mm x 35 mm rails

d. GLEX-FT-84-HC

1) 16AWG Galvanized steel backbox

2) Height: 63 in (1600.2 mm)

3) Width: 15.25 in (387.35mm)

4) Depth: 4.5 in (114.3 mm)

5) 120-277 VAC.

6) DIN Rail Detail: (10) 342 mm x 35 mm rails

2. Control Modules

a. DIN-DALI-2

1) Din-rail mount Module shall contain 2 channels of digital DALI loop containing 64 devices per channel.

2) Sensors and user interfaces shall not reside on the DALI bus. These accessories shall be networked to the DALI interface controller as part of the turnkey solution. Reference specifications hereto after for more details on sensor and user interface selections that shall be compatible with the turnkey DALI solution.

3) The DALI bus shall be class 2 (1) twisted pair #18 AWG or larger and be shielded. Install in free air per DIV 26.

4) Module shall contain an override input to allow an external contact closure to override the control system program and force each device to its “System failure level”

5) Module shall contain an internal power supply

6) 32 to 104 degrees Fahrenheit operating temperature

7) DIN-DALI-2 module is utilized in GL-DALI spacebuilder

b. DIN-DMX- [1][2] UNIVERSE

1) DIN-rail mountable module shall contain [1] or [2] universe of DMX control.

2) Controller shall allow individually controllable and independently running timelines and scenes.

3) Controller shall be scalable allowing multiple units to connect via ethernet.

4) Programmed and configured using proprietary system software.

5) Shall support RDM, SACN, and ART-NET.

6) DIN-DMX module is utilized in GL-DMX spacebuilder

c. GLA-ISP-4R-RJ45A

1) DIN-rail mountable module shall contain 4 optically isolated DMX outputs

2) Shall support RDM, SACN, and ART-NET.

3) Terminations utilize convenient RJ45 568B connections

d. DIN-AO8

1) Eight 0-10V analog output control ports

2) Interface for 3rd-party lighting and heating/cooling

3) Fully programmable functionality via DIN-AP2

4) Setup via front panel or software

5) Override input

6) Cresnet communications

7) 6M wide DIN rail mounting

e. DIN-IO8

1) 8 Versiport I/O ports

2) Interface for 3rd-party sensors, detectors, contact closures, and alarms

3) Fully programmable functionality via DIN-AP2

4) Cresnet communications

5) 6M wide DIN rail mounting

f. DIN-4DIMFLV4

1) Provides 4 channels of 0-10 Volt dimming control

2) Supports 120 and 220 to 240 Volt, 50/60 Hz applications

3) Allows switching of lighting and exhaust fans[1]

4) Includes an override input

5) Communicates using Cresnet®

6) Sets up via the front panel or through software

7) Offers programmable functionality via DIN-AP3

8) Mounts on a 9M wide DIN rail

9) CEC Title 24 2013 Compliant

g. DIN-1DIM4

1) 4 channels of dimming

2) 120 to 277 Volt 50/60 Hz operation

3) Selectable non-dim mode

4) Master air-gap relay

5) Override input

6) Cresnet® communications

7) Setup via front panel or software

8) Programmable functionality via DIN-AP3

9) 12M wide DIN rail mounting

10) CEC Title 24 2013 Compliant

h. DIN-1DIMU4

1) 4 channels of forward or reverse phase dimming

2) Auto load detection

3) 120 to 240 Volt 50/60 Hz operation

4) Selectable non-dim mode

5) Extreme stability in noisy environments

6) Short circuit and overload protection

7) Master air-gap relay

8) Override input

9) Cresnet® communications

10) Setup via front panel or software

11) Programmable functionality via DIN-AP3

12) 12M wide DIN rail mounting

13) CEC Title 24 2013 Compliant

i. DIN-8SW8-I

1) 8 channels of power switching

2) 8 voltage-driven isolated digital inputs

3) Support for 120 to 240 Volt 50/60 Hz lighting and motor loads

4) Override input

5) Cresnet® communications

6) Setup via front panel or software

7) Programmable functionality

8) 9M wide DIN rail mounting

j. DIN-SACN-DMX

1) Converts between DMX512A and sACN, Art-Net, or ESP protocols

2) Enables distribution of DMX over Ethernet or Wi-Fi®

3) Enables Crestron® control of DMX lighting fixtures and systems

4) Supports a single universe Ethernet to DMX node in output mode

5) Supports a single universe DMX to Ethernet node in input mode

6) Supports broadcast or unicast (unicast in input mode only)

7) Supports HTP/LTP merging of up to 2 DMX sources (output mode only)

8) Supports RDM over Art-Net

9) Easy web browser based setup and firmware update

10) 4U 35 mm DIN rail mountable

11) PoE or 7-24 Volt DC powered (power supply not included)

2.6 USER INTERFACES

A. Product: Crestron C2N-CBD-P-W [B][A]-S

1. Provide keypad quantities and locations as specified herein and shown on the contract drawings.

2. Field configurable remote keypad with auto-adjusting backlight illuminating replaceable, engravable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.

3. Trimmed using decorator style faceplate (not included) or Crestron decorator-style faceplates (FP-G series)

4. Cresnet connected for power and communication

5. Minimum Buttons: 2, Maximum Buttons: 8.

6. Color shall be White [black][almond].

7. Mounting: Mounts in a 1-gang or larger electrical box or mud ring

B. Product: Crestron GLPPA-KP[1][2][3][4]-W [B][A]-S

1. Connects to lighting controller with class II (2) #18 AWG or greater conductors.

2. Colors shall be white [black] [almond].

3. Scene Functions

a. Rocker (ON/OFF/hold to dim) or 4 Button (ONSCENE 1/SCENE 2/OFF)

1) Product: Crestron GLPPA-KP-W [B][A]-S

4. Zone Functions

a. Rocker controlling zone 1 (ON/OFF/hold to dim)

1) Product: Crestron GLPPA-KP1-W[B][A]-S

b. Rocker controlling zone 2 (ON/OFF/hold to dim)

1) Product: Crestron GLPPA-KP2-W[B][A]-S

c. Rocker controlling zone 3 (ON/OFF/hold to dim)

1) Product: Crestron GLPPA-KP3-W[B][A]-S

d. 4 Button controlling zones 1-3 (ZONE 1 toggle/ZONE 2 toggle/ZONE 3 toggle/OFF)

1) Product: Crestron GLPPA-KP4-W[B][A]-S

C. Configuration Remote Control

1. Lighting controller shall be adjustable using the handheld battery-operated configuration remote.
2. Pre-programmed at the factory, no configuration or programming required.
3. Remote shall provide features:
   a. Zone control
   b. Scene setting
   c. Motion sensor mode select and timeout
   d. Daylight sensor calibration
4. Product: Crestron GLPPA-REMOTE-PROG

2.7 FACEPLATES

1. keypad devices Provide decorator faceplates for all keypad devices.
2. Multiple devices adjacent to door jams shall be ganged together.
3. Decorator faceplates shall be white [Black][Almond] and shall match in texture and color of the
4. Products:
   a. FP-G1-W [B][A]-S
   b. FP-G2-W [B][A]-S
   c. FP-G3-W [B][A]-S
   d. FP-G4-W [B][A]-S

B. Touch Screens

1. TFT active-matrix color LCD touch screen
2. Projected capacitive, 5-point multi-touch technology
3. 24-bit 16.7M colors, and dual-window HD video, HDTV, and high-resolution RGB streaming multimedia, IP intercom, and web browsing capabilities. Dynamic graphics and text capability. Enables custom control screen programming.
4. 5 hard keys pushbuttons.
5. Bidirectional 10/100 Mbps Ethernet communication.
6. H.264 and MJPEG streaming video.

7. 5.0 MP camera.
8. Built-in microphone and speaker with multi-language voice recognition.
9. Rava SIP intercom.
10. Connected via IEEE 802.3af Class 3 PoE Powered Device.
11. Surface mount over 2-gang or 3-gang electrical box.
12. Color: [Black] [White].
13. Products
    a. Crestron TSW-760-W-S (7” white, 2-gang mounted)
    b. Crestron TSW-1060-W-S (10” white, 3-gang mounted)
    c. Crestron TSW-560P-W-S (5” white, 1-gang mounted)
    d. Crestron TSW-760-B-S (7” black, 2-gang mounted)
    e. Crestron TSW-1060-B-S (10” black, 3-gang mounted)
    f. Crestron TSW-560P-B-S (5” black, 1-gang mounted)

C. XPANEL Interface: Virtual Touch Screen
1. Touch screen user interface, network-connected lighting management interface running on Crestron lighting control processor to provide lighting control, daylight harvesting, occupancy sensing, lighting schedules and overall adjustment to system functionality
2. Virtual touch screen is to be accessible via computer or laptop interface furnished by other.
3. Access to XPanel shall be via browser-based IP address or .EXE file application.
4. Product: Crestron XPANEL

D. Mobile App Interface: Virtual Touch Screen via Crestron Mobile Pro® Control App for iPhone® and Android™
1. Mobile phone application for network-connected lighting management interface configured with any Crestron 3-Series lighting control processor to provide lighting control, daylight harvesting, occupancy sensing, lighting schedules and overall adjustment to system functionality, as setup and configured by certified Crestron programmer / service provider (CSP).
2. Virtual touch screen is to be accessible via iPhone® and Android™ (furnished by others)
3. Access to a modified XPanel via application interface configuration settings.
4. Product: CRESTRON-MOBILE-PRO as provided by app store associated with iPhone® and Android™ devices.

PART 3 – SENSORS

3.1 DUAL-TECHNOLOGY MOTION SENSORS

A. Product: Crestron GLS-ODT-C-CN
1. Characteristics

2. Detects movement within space while reducing false triggering or shutoffs while space is occupied.
3. Both technologies shall be trigged to force on, one or the other must be triggered to reset time.
4. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor.
5. Sensitivity is independently adjustable for installed conditions.
6. Delayed time off adjustment.
7. Walk-through mode.
8. Equipped with 4-wire interface for direct connection to control bus.
9. Includes connection port for remote mount photocell.
10. Coverage: 360 deg. 2000 SQFT.
11. Setup and commissioning parameters shall be configurable via handheld wireless remote.
12. Mounts to a 3” octagon box.

B. Product: Crestron GLS-ODT-C-NS

1. Characteristics

a. Detects movement within space while reducing false triggering or shutoffs while space is occupied.
b. Both technologies shall be trigged to force on, one or the other must be triggered to reset time.
c. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor.
d. Sensitivity is independently adjustable for installed conditions.
e. Delayed time off adjustment.
f. Walk-through mode.
g. Equipped with 4-wire interface for direct connection to control bus.
h. Includes connection port for remote mount photocell.
i. Coverage: 360 deg. 2000 SQFT.
j. Setup and commissioning parameters shall be configurable via handheld wireless remote.
k. Mounts to a 3” octagon box.

C. Product: Steinel GLA-DT-QUATTRO-COM1[2]-24

1. Characteristics

a. Sensing Technology: Passive infrared (PIR), single pyro, 11 detection levels, 520 switching zones, ultrasonic 40 kHz.

b. Mounts to a 4” octagon box.

c. Time Delay Setting

d. Light Level Setting: 1 - 100 fc (10 - 1000 lux)

e. Dip Switch Settings

f. HVAC dry contacts: (COM2 Version only)

g. Test Mode: Dip switch setting or programming remote

h. Ultrasonic Coverage at 9 feet (2.7 m):

1) Presence: Maximum 20 feet by 20 feet (6 by 6 m) or 400 sf (36 sm).

2) Radially and Tangentially: Maximum 32 feet by 32 feet (10 by 10 m) or 1,000 sf (100 sm).

i. PIR Detection Zones:

1) Presence: Maximum 10 feet by 10 feet (3 by 3 m) or 100 sf (9 sm).

2) Radially: Maximum 13 feet by 13 feet (4 by 4 m).

3) Tangentially: Maximum 26 feet by 26 feet (8 by 8 m).

D. Product: Steinel GLA-DT-CM-COM1[2]-24

1. Characteristics

a. Sensing Technology: Passive infrared (PIR), single pyro, 11 detection levels, 520 switching zones, ultrasonic 40 kHz

b. Mounting:

1) Direct to the wall or ceiling with anchor bolts

2) Ceiling mounted with 1/2 inch snap in chase nipple, washer and lock nut. Time Delay Setting

c. Light Level Setting: 1 - 100 fc (10 - 1000 lux)

d. Dip Switch Settings

e. HVAC dry contacts: (COM2 Version only)

f. Test Mode: Dip switch setting or programming remote

g. Ultrasonic Coverage at 9 feet (2.7 m):

1) Presence: Maximum 22 feet (7 m) or 426 sf (130 sm).

2) Radially: Maximum 38 feet (11.5 m) or 1,236 sf (376 sm).

3) Tangentially: Maximum 26 feet (8 m) or 718 sf (218 sm).

h. PIR Detection Zones:

1) Presence: Maximum 22 feet (7 m) or 440 sf (134 sm).

2) Radially: Maximum 26 feet (8 m) or 655 sf (200 sm).

3) Tangentially: Maximum 82 feet (25 m) or 5290 sf (1612 sm).

E. PIR Motion Sensors

1. Product: Steinel GLA-IR-QUATTRO-COM1[2]-24

a. Characteristics

1) Sensing Technology: Passive infrared (PIR)

2) Mounts to a 4” octagon box.

3) Delay Setting

4) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

5) Dip Switch Settings

6) HVAC dry contacts: (COM2 Version only)

7) Test Mode: Dip switch setting or programming remote

8) Coverage at 9 feet (2.7 m): 360 deg square mechanically scalable detection zones.

a) Presence: Maximum 15 feet by 15 feet (4.7 by 4.7 m) or 225 sf (21.2 sm).

b) Radially: Maximum 15 feet by 15 feet (4.7 by 4.7 m) or 225 sf (21.2 sm).

c) Tangentially: Maximum 23 feet by 23 feet (7 by 7 m) or 529 sf (50.4 sm).

2. Product: Steinel GLA-IR-QUATTRO-HD-COM1[2]-24

a. Characteristics

1) Sensing Technology: Passive infrared (PIR)

2) Mounts to a 4” octagon box.

3) Delay Setting

4) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

5) Dip Switch Settings

6) HVAC dry contacts: (COM2 Version only)

7) Test Mode: Dip switch setting or programming remote

8) Coverage at 9 feet (2.7 m): 360 deg square mechanically scalable detection zones.

a) Presence: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).

b) Radially: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).

c) Tangentially: Maximum 65.5 feet by 65.5 feet (20 by 20 m) or 4,290.25 sf (400 sm).

3. Product: Steinel GLA-IR-CM-COM1[2]-24

a. Characteristics

1) Sensing Technology: Passive infrared (PIR)

2) Mounting:

a) Direct to the wall or ceiling with anchor bolts

b) Ceiling mounted with 1/2 inch snap in chase nipple, washer and lock nut. Time Delay Setting

3) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

4) Dip Switch Settings

5) HVAC dry contacts: (COM2 Version only)

6) Test Mode: Dip switch setting or programming remote

7) Coverage at 9 feet (2.7 m): 360 deg square mechanically scalable detection zones.

a) Presence: Maximum 22 feet (7 m) or 440 sf (134 sm).

b) Radially: Maximum 26 feet (8 m) or 655 sf (200 sm).

c) Tangentially: Maximum 82 feet (25 m) or 5290 sf (1612 sm).

F. Ultra Sonic Motion Sensors

1. Product: Steinel GLA-US-QUATTRO-COM1[2]-24

a. Characteristics

1) Sensing Technology: Ultrasonic

2) Mounts to a 4” octagon box.

3) Delay Setting

4) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

5) Dip Switch Settings

6) HVAC dry contacts: (COM2 Version only)

7) Test Mode: Dip switch setting or programming remote

8) Coverage at 9 feet (2.7 m):

9) Presence: Maximum 20 feet by 20 feet (6 by 6 m) or 400 sf (36 sm).

10) Radially and Tangentially: Maximum 32 feet by 32 feet (10 by 10 m) or 1,000 sf (100 sm).

2. Product: Steinel GLA-US-HALLWAY-COM1[2]-24

a. Characteristics

1) Sensing Technology: Ultrasonic

2) Mounts to a 4” octagon box.

3) Delay Setting

4) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

5) Dip Switch Settings

6) HVAC dry contacts: (COM2 Version only)

7) Test Mode: Dip switch setting or programming remote

8) Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 65 feet (2 by 20 m) or 422.5 sf (40 sm).

3. Product: Steinel GLA-US-ONEWAY-COM1[2]-24

a. Characteristics

1) Sensing Technology: Ultrasonic

2) Mounts to a 4” octagon box.

3) Delay Setting

4) Light Level Setting: 1 - 100 fc (10 - 1000 lux)

5) Dip Switch Settings

6) HVAC dry contacts: (COM2 Version only)

7) Test Mode: Dip switch setting or programming remote

8) Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 33 feet (2 by 10 m) or 214.5 sf (20 sm).

3.2 DAYLIGHT SENSORS

A. Indoor Daylight Sensor (Open Loop)

1. Continually monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.

2. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.

3. Light sensitivity: 3 to 6,000 foot-candles

4. Mounting: [Ceiling flush mounted] [Ceiling surface mounted] [As indicated].

5. Product: Crestron GLS-LOL

B. Indoor Daylight Sensor (Closed Loop)

1. Continually monitors daylight at work station location to enable daylight harvesting or lumen maintenance applications to provide control of room lighting based on lighting level at workstation.

2. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.

3. Light sensitivity: 0 to 70 foot-candles

4. Mounting: [Ceiling flush mounted] [Ceiling surface mounted] [Wall flush mounted] [Wall surface mounted] [As indicated].

5. Product: Crestron GLS-LCL

C. Outdoor Daylight and Color Temperature Sensor

1. Measures true color temperature and intensity of natural sunlight.

2. Communicates over serial to control system to match indoor lighting with the outdoors.

3. Outdoor rated for rooftop installation.

4. IP67 for watertight operation.

5. CCT of 2,000K to 25,000K.

6. 0 to 100,000 lux.

7. 360 degree semispherical.

8. Product: GLS-LCCT

D. Partition Sensors

1. Single sided diffuse reflective sensing technology.

2. Digital device with control bus connectivity.

3. Surface mounted to 1-gang back box.

4. Trim using decorator face plate to match mounting surface.

5. Product: Crestron GLS-PART-CN

E. Sensor Interface Module

1. Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.

2. Product: Crestron GLS-SIM

3.3 CONTROL PROCESSOR PANEL AND DISTRIBUTION PANELS

A. Product Family – GLNET and CLP

B. Control processor Panels shall be provided in quantities and locations per the contract drawings, or as required for a fully networked lighting control system.

C. Control processor panels shall be factory assembled in a UL508 Panel shop

D. Shall include the following equipment to support lighting control devices

1. Cabinets
    a. Made of 16AWG galvanized steel
    b. NEMA 1 rated
    c. Product: DIN-EN
2. Processors
    a. Crestron 3-series control system
    b. Modular architecture supports multiple simultaneous running programs.
    c. Ethernet 10/100Base-T and Cresnet Connected
    d. Astronomical time clock with events stored in non-volatile RAM
    e. Native BACnet/IP with support for up to 500 BACnet objects
    f. Built-In Web Server: IIS v.6.0
    g. SNMP remote management.
    h. Active Directory support.
    i. IPv6 ready.
    j. DHCP and DNS Support
    k. Native Email Client
    l. Remote Diagnostics
    m. Remote Program Loading and Administration
    n. SSL security plug in
    o. Support user assigned or dynamic IP address.
    p. Product: Crestron DIN-AP3
3. Power Supplies
    a. Provide regulated 24 VDC power supplies as required to support lighting control equipment
    b. 120 VAC input
    c. Product: Crestron DIN-PWS60
4. Cresnet to Ethernet Bridge
    a. 24v DC Input

b. IEEE 802.3 Power of ethernet connection.

c. Serial communication

d. USB 2.0 for setup.

e. Product: DIN-CENCN-2-POE

5. Ethernet Distribution

a. 48V DC Input, 100-240 VAC 50/60 Hz Supply

b. (5) [16] IEEE 802.3 Ethernet Ports

c. 32 to 104 degrees Fahrenheit

6. Floor Hub

a. Connects up to 200 Crestron ZUMMESH-NETBRIDGE devices.

b. Contain astronomical time clock.

c. Maintenance is performed via standard web browser.

d. 1 rack unit mounted

e. Product: Crestron ZUM-FLOOR-HUB

7. GLNET-CN

a. Enclosure: DIN-EN-2X18

1) 16AWG Galvanized steel backbox

2) 120 Volts AC, 60 Hz

3) Height: 12.32 in (323 mm)

4) Width: 14.13 in (359 mm)

5) Depth: 4.38 in (111 mm)

6) DIN Rail Detail: (2) 342 mm x 35 mm rails

8. GLNET-ZUM

a. Enclosure: DIN-EN-3X18

1) 16AWG Galvanized steel backbox

2) 120 Volts AC, 60 Hz

3) Height: 23.50 in (597 mm)

4) Width: 14.38 in (366 mm)

5) Depth: 4.44 in (113 mm)

6) DIN Rail Detail: (3) 342 mm x 35 mm rails

9. GLNET-ZUM-CN
    a. Enclosure: DIN-EN-6X18
        1) 16AWG Galvanized steel backbox
        2) 120 Volts AC, 60 Hz
        3) Height: 38.88 in (989 mm)
        4) Width: 14.38 in (366 mm)
        5) Depth: 4.44 in (113 mm)
        6) DIN Rail Detail: (6) 342 mm x 35 mm rails
10. CLP-HUB-SW-POE-5
    a. Enclosure: DIN-EN-2X18
        1) 16AWG Galvanized steel backbox
        2) 120 Volts AC, 60 Hz
        3) Height: 12.32 in (323 mm)
        4) Width: 14.13 in (359 mm)
        5) Depth: 4.38 in (111 mm)
        6) DIN Rail Detail: (2) 342 mm x 35 mm rails
11. CLP-HUB-SW-POE-10
    a. Enclosure: DIN-EN-2X18
        1) 16AWG Galvanized steel backbox
        2) 120 Volts AC, 60 Hz
        3) Height: 23.50 in (597 mm)
        4) Width: 14.38 in (366 mm)
        5) Depth: 4.44 in (113 mm)
        6) DIN Rail Detail: (3) 342 mm x 35 mm rails
12. CLP-HUB-SW-POE-16
    a. Enclosure: DIN-EN-6X18
        1) 16AWG Galvanized steel backbox
        2) 120 Volts AC, 60 Hz
        3) Height: 38.88 in (989 mm)
        4) Width: 14.38 in (366 mm)
        5) Depth: 4.44 in (113 mm)

6) DIN Rail Detail: (6) 342 mm x 35 mm rails

3.4 UL924 EMERGENCY OVERIDE

A. Phase Loss Sensor

1. Lighting control panels shown on the contract drawings as emergency life safety shall contain UL924 listed modules and OVR inputs.

2. Provide phase loss sensor with sense for all 3 phases.

3. Upon loss of any of the 3 phases, the phase loss sensor shall trigger the emergency life safety panel's override port(s).

4. Product: Crestron GLS-PLS-120/277.

B. Bypass Relays

1. Switched and 2-wire dimmed loads

a. The UL924 listed 2-wire Emergency Shunt Relay shall allow emergency power to go around the control device to bring emergency power to the load.

b. Product: GLA-ESR

C. Automatic Load Control Relays (ALCR)

1. Switched Loads

a. UL924 listed 2-wire automatic load control relay shall bring emergency life safety lights on to 100% upon loss of power

b. Upon the loss of normal power, the ALCR shall bypass the control device allowing emergency power to access the loads regardless of switch position.

c. Products:

1) Crestron GLA-EPC-PM

2) Crestron GLA-EPC-2

2. 4-Wire dimming loads

a. UL924 listed 4-wire automatic load control relay shall bring emergency life safety lights on to 100% upon loss of power

b. Upon the loss of normal power, the ALCR shall bypass the control device allowing emergency power to access the load regardless of switch position.

c. The ALCR shall contain a normally open relay to open the control wires allowing the lights to come to full bright.

d. The ALCR shall allow for integration with fire alarm.

e. Product: Crestron GLA-EPC-FLV

D. UL1008 Emergency Override

1. Automatic transfer switch (ATS)

2. All dimming and switching loads

a. UL1008 listed automatic transfer device shall transfer emergency power to the load upon 100% loss of power.

b. Upon loss of normal power, the ATS shall allow the flow of emergency power from the emergency circuit regardless of switch position.

c. The ATS shall operate on the branch side of the circuit

d. The ATS shall allow integration with fire alarm

e. Product: Crestron GLA-EPC-D-F-ATS

3.5 PROGRAMMING AND CONFIGURATION SOFTWARE

A. Lighting system configuration software shall allow custom programming for lighting control system.

B. Lighting system configuration software shall generate custom software control interface modules for communication with compatible remote integrated systems.

C. The lighting system configuration software shall be GUI based for programming and development.

D. The custom software control interface shall include the following control data:

1. Complete lighting system control functions.

2. System specific control sets for sub systems and supervisory systems

3. Bidirectional digital and analog data communication.

4. Bidirectional serial data communication.

3.6 CONDUCTORS AND CABLING

A. Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors."

B. UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

C. Communications Control Cable, Non-Plenum Rated: 22 AWG data pair stranded bare copper, and 18 AWG power pair stranded bare copper, Type CM.

1. Product: Crestron CRESNET-NP.

D. Communications Control Cable Plenum Rated: 22 AWG data pair, stranded bare copper and 18 AWG power pair, stranded bare copper, Type CMP, complying with NFPA 262.

1. Product: Crestron CRESNET-P.

E. Communications High-Power Control Cable, Non-Plenum Rated: 22 AWG stranded bare copper data pair, and 12 AWG stranded bare copper power pair, Type CM.

1. Product: Crestron CRESNET-HP-NP.

PART 4 – EXECUTION

4.1 FIXTURE TESTING

A. Contractor shall provide lighting control factory test reports for each fixture specified on this project

B. Test report shall include

1. Confirmation of compatibility with control device

2. Dimming Range

3. Performance notations

4.2 PLUG LOAD CONTROL

A. Plug load controls as shown on the contract drawing shall be part of the lighting control system.

B. Plug loads shall operate in occupancy mode (Auto-on, Auto-off).

4.3 ENGRAVING

A. Keypad buttons shall be factory engraved using laser technology

B. Initial shipment of keypads shall be factory engraved per the sequence of operations specified herein and shown on the contract documents

C. Custom keypad engravings shall be provided as part of the close out procedures.

4.4 BMS INTEGRATION

A. The lighting control system shall be integrated with the BMS system as specified in DIV. 25.

B. Communication shall occur using BACNET/IP Protocol.

C. Contractor shall provide licenses for each of the following objects and shared amongst the BMS system

1. Occupancy Status

2. Zone On/Off/Dim

3. Photocell reading

D. The lighting control system shall also accept time clocked events from the BMS system

E. Provide necessary coordination labor for integration of all BACNET objects listed.

4.5 AV INTEGRATION

A. The lighting control system shall be integrated with the AV solutions as specified in DIV.26

B. The lighting and AV systems shall interface via Ethernet communication or RS232.

C. Contractor shall provide ethernet drops as required for the lighting control system to connect to the AV system.

D. The following objects shall be shared with the AV system:

1. Occupancy Status

2. Zone On/Off/Dim

3. Photocell reading

4. Scene preset recalls

E. Provide necessary coordination labor for integration of all AV objects listed hereto before.

4.6 SYSTEM FUNCTIONS AND SEQUENCES

A. The system shall be capable of the following lighting control functions:

1. Scene Creation: Store levels of selected fixture circuits in preset groups.
2. Scene Recall: recall previous stored scenes.
3. All zones off
4. Raise/lower level of all zones
5. Password entry for touchscreen access
6. Room/Zone selection
7. Raise/lower room shades
8. Schedule events to be automatically recalled

4.7 USER INTERFACE CONTROL FUNCTIONS

A. The keypad interface shall be capable of the following system control functions:

1. Scene Recall
2. Raise/Lower
3. Off

B. Touchscreen and Virtual touch screen interfaces shall be capable of the following system control functions:

1. Password Entry
2. Multiple levels
3. Room/Zone selection
4. Scene Recall
5. Raise/Lower
6. Shade Control
7. Timeclock Events
8. Customer logo and color scheme

C. Optional control sequences for advanced control:

1. Occupancy adjustments
2. Sensor Timeout
3. Control logic (occupancy or vacancy)
4. Lighting Scenes
5. Individual zone control override

6. Timeclock adjustments
7. Modify timeclock activation schedule
8. Select/unselect pre-programmed timeclock events
9. Display all timeclock events
10. Daylight Harvesting Adjustments
11. Low end trim
12. Response time
13. Zone control
14. Scene Recall
15. Fade time
16. Color scene recall

4.8 TIME CLOCK EVENTS

A. The lighting control system shall have astronomical time clocked events. 6-time clock events shall be provided.

B. End user shall have the option to create additional time clock events via touch screen or XPANEL interfaces.

4.9 INSTALLATION

A. Prior to installation, examine work area to verify measurements, and that commencing installation complies with manufacturer's requirements.

B. Comply with requirements of Division 26 Sections "Common Work Results for Electrical."

C. Do not install network power controls until space is enclosed, HVAC systems are running, and overhead and wet work in space are complete.

D. Install network power switching controls in accordance with manufacturer's instructions.

E. Grounding: Provide electrical grounding in accordance with NFPA 70.

4.10 MANUFACTURER SUPPORTED SERVICES

A. Pre-wire

1. Manufacturer trained and authorized personnel shall provide on-site visit during the rough-in stage of the installation. At this time wiring topologies and terminations shall be reviewed with the Contractor.

B. Startup

1. Provide manufacturer's certified system startup and adjustment.
2. Switch each load on and off with manual line test feature of the power switching module before installing processors.
3. Perform operational testing to verify compliance with Specifications. Adjust as required.

C. Tuning

1. Within 3 months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

D. Training

1. Within 30 days, Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.

2. Demonstration: Schedule demonstration with Owner.

3. Training: Train Owner's personnel to operate, maintain, and program network power switching systems.

4. Furnish set of approved submittals, and record drawings of actual installation for Owner's personnel in attendance at training session.

SECTION 26 12 19

PAD MOUNTED, LIQUID FILLED, MEDIUM VOLTAGE TRANSFORMER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Transformer shall meet all specific utility company requirements.

B. Extent of liquid filled transformer work is indicated by drawings and specification.

C. Refer to applicable Division 26 sections for testing requirements, wire/cables, electrical raceways, and boxes and fittings.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for liquid filled transformers.

B. Shop Drawings: Submit shop drawings of liquid filled transformer showing accurately scaled equipment locations and spatial relationships to associated pads, primary conduit and secondary conduit.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of liquid filled types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer Qualifications: Firm with at least 5 years experience of successful installation experience with projects utilizing liquid filled transformers similar to that required for this project.

C. Code Compliance: Units shall be constructed in accordance with ANSI Standard C57.12.26 (latest revision).

All characteristic, definitions, terminology, and voltage designations and tests, except as otherwise specified herein, shall be accordance with the following American National Standard Requirements, Terminology, and Test Code for Distribution, Power and Regulating Transformers.

General Requirements, C57.12.00 (IEEE Std 462) (latest revision).
Terminal Marking and Connections, C57.12.70 (latest revision).
Terminology, C57.12.80, including Supplement C57.12.80a (latest revision).
Test Code, C57.12.90 (IEEE Std. 262) (latest revision).

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid filled transformer properly packaged in factory-fabricated palletized crate.

B. Store liquid filled transformers in a clean dry space; protect from weather and construction traffic.

C. Handle liquid filled transformer carefully to avoid breakages, impacts, denting and scoring finish. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including underground duct banks to properly interface installation of liquid filled transformers with other work.

B. Sequence liquid filled transformer installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.7 MAINTENANCE

A. Maintenance Data: Submit maintenance data and parts list for liquid filled transformers; including “trouble shooting” maintenance guide. Include that data, product data and shop drawings in a maintenance manual; in accordance with requirements of Division 1.

B. Maintenance Stock, Fuses: For types and rating required, furnish additional set of spare fuses.

PART 2 - PRODUCTS

2.1 LIQUID FILLED TRANSFORMERS

A. Provide transformers as indicated here-in with KVA rating(s) per drawings. Transformer rated KVA shall be at altitude of project with 100% load, i.e.: increase transformer size to achieve KVA indicated on drawings if necessitated by project altitude.

B. Transformer shall meet all specific utility company requirements, and be approved by utility company.

C. General: Provide a 3-phase delta (primary) – WYE (secondary), dead front, loop feed, oil-filled, pad-mounted transformer with a 5.75% impedance and kva and voltages indicated on drawing with two 2-1/2% full capacity above normal and two 2-1/2% below normal taps. Tap changes shall be externally operated. The average temperature rise of the windings, measured by the resistance method, shall be 65° C when the transformer is operated at rated kVA output in a 40° C ambient. The transformer shall be capable of being operated at rated load in a 30° C average, 40° C maximum ambient, as defined by IEEE C57.12.00™ without loss of service life expectancy. Coolant and insulating fluid shall be less flammable seed-oil based fluid.

D. The pad mounted, compartmental type, liquid immersed, self-cooled transformer shall consist of the transformer tank with high and low voltage cable terminating compartment. The transformer tank and compartment shall be assembled as an integral unit for mounting on a pad. There shall be no exposed screws, bolts, or other fastening devices which are externally removable. There shall be no openings through which foreign objects such as sticks, rods, or wires might contact live parts. There shall be means of padlocking the compartment door(s). The construction shall limit the entry of water (other than flood water) into the compartment so as not to impair the operation of the transformer.

E. Full height, air-filled incoming and outgoing terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the incoming compartment on the left. The high-voltage (incoming) compartment will be accessible only after the door to the low voltage (outgoing) compartment has been opened. To facilitate making connections and permit cable pulling, the doors and compartment hood shall be provided to permit rolling or skidding of unit into place over conduit studs in foundation.

F. The compartments will have hinged doors equipped for latching in the open position. The high-voltage compartment door will have a fastening device which is accessible only through the low-voltage compartment.

G. The hinge assemblies shall be made of corrosion resistant material. Stainless steel hinge pins of 3/8 inch minimum diameter will be provided.

H. Both compartment doors must be capable of being secured with a single padlock having a maximum ½ inch diameter shackle.

I. Lifting provisions in accordance with ANSI Standards shall be provided.

J. Jacking and rolling provisions shall be provided.

K. The instruction nameplate is to be located in the low voltage portion of the compartment and shall be readable with cables in place. Where the nameplate is mounted on a removable part, the manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.

L. Transformer tank shall be seal tank construction with a welded main cover.

M. Bolded tamper resistant handhole shall be provided in the tank cover for access to internal connections.

N. Provisions for tank grounding shall be supplied in both the high voltage and low voltage compartments. These provisions shall consist of:

1. 500kVA and below: ½-13 UNC tapped hole 7/16 inch deep.
2. 750kVA and above: (2) ½-13 UNC tapped holes ½ inch deep.

O. Low voltage bushings shall be tinned, spade type with 9/16 inch holes spaced on ¾ inch centers in accordance with the Latest Revisions of ANSI.

P. Primary (separable insulated high voltage connector) bushings for looped primary cable systems.

1. High Voltage Terminating and Equipment: The high voltage terminations and equipment shall be dead front and conform to ANSI C57 requirements. Provide with bushing wells and inserts for use with elbow terminators and parking stands for mounting accessory equipment. The terminations and equipment shall be arranged for loop feed. Elbow termination shall be Elastimold load break up to 200A, non-load break at 600A, with test point and fault indicators.
2. Six bushing wells in accordance with ANSI Standard C119.2.

Q. The following are to be provided on all units.

1. One inch filling provision.
2. One inch drain provision.
3. Liquid level indication.

R. Three Bayonet type, oil immersed, expulsion fuses accessible through the primary compartment. The fuses shall be removable using a hot stick, (without disassembly of the primary cabinet) for external replacement of fuse cartridges.

S. One loop feed, internal, oil-immersed, gang-operated, loadbreak, manually operated switch for a looped, primary cable system. The switch shall be a four position loop feed switch. The switch must be capable of switching 600 amperes to permit sectionalizing of the looped system.
The switch handles shall be located in the primary compartment and must be hot stick operable. Six primary bushings will be provided.

T. Low Voltage Terminations and Equipment: The low voltage bushings shall be molded epoxy and provided with blade type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing grounded to the transformer tank by a removable grounding strap. Wye-Wye connected transformers shall have the high and low voltage neutrals internally tied with a removable link for testing.

U. Accessories:

1. Nameplate in low voltage compartment.
2. One inch drain valve with sampling device.
3. One inch upper filter press and filling plug.
4. Liquid level indication (pipe plug at 25ºC. oil level).
5. Dial type thermometer.
6. Liquid level gauge.
7. Pressure relief valve.
8. Mounting provision for low voltage current transformers and potential transformers. Current transformers (CTs) and potential transformers (PTs) shall be provided with unit where necessary to support metering as specified here-in or on drawings. The addition of CTs or PTs shall not cause the quantity of outgoing parallel feeders to be reduced below the quantity normally available with CTs and PTs.
9. Instruction nameplates shall include the number of gallons of transformer oil. High voltage warning signs reading “DANGER KEEP OUT” shall be permanently attached to each side of transformer stations. Stainless steel ground connection pads shall be provided in both the high and low voltage compartments.

V. Testing - Tests shall be conducted in accordance with the provisions of IEEE C57.12.90™ and shall include, as a minimum, the following tests:

1. Ratio
2. Polarity
3. Phase Rotation
4. No-Load Loss
5. Excitation Current
6. Impedance Voltage
7. Load Loss
8. Applied Potential
9. Induced Potential
10. QA Impulse Test

W. Provide unit-mounted digital meter with network tie-in capability. Meter to show phase amps, phase to phase and phase to neutral voltage, peak demand and time/date of occurrence and kilowatt hours.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment to provide adequate spacing for cooling air circulation.

B. Identify transformers in accordance with Division 26 Section “Electrical Identification”.

C. Tighten electrical connector and terminals in accordance with manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and Ul 486B.

D. Verify transformer location has adequate clearance from combustible materials and building openings.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:

1. Coordinate size of equipment bases with actual unit sized provided. Construct base 4 inches high and 2 inches larger in all direction than the overall dimensions of the supported unit.
2. Form fiberglass per manufacturers' instructions.
3. Install anchor bolts and sleeves to facilitate securing units.

3.3 GROUNDING

A. Ground transformers and tighten connections to comply with tightening torques specified in UL Standard 486A.

3.4 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, direct and construction debris. Touch up scratches and mars of finish to match original finish.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION

SECTION 26 22 00

LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

B. Requirements of the following Division 26 Sections apply to this section.

1. “Electrical Requirements.”

1.2 SUMMARY

A. This section includes general purpose and specialty dry type transformer with winding rated 600V or less, with capacities up to 1000 KVA.

B. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner. All dry type transformers shall be in accordance with Drawings and Specifications.

C. Related Sections: The following Division 26 Sections contain requirements that relate to this section:

1. “Electrical Identification” for signs associated with transformer installations.

D. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project.

1.3 SUBMITTALS

A. General: Prior to fabrication submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product data for each transformer, including dimensional plans view electrical rooms, sections, and elevations showing minimum clearances, installed devices, and material lists.
2. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.
3. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.
4. Product Test Reports: Certified copies of manufacturer’s design and routine factory tests required by the referenced standards.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: A firm member of NEMA who is regularly engaged in manufacturing components that comply with the requirements of these Specifications and that have been used on at least five projects of similar size and scope as this Project, and whose products have been in satisfactory use in similar service for not less then 10 years.

B. Provide dry type transformers produced by a manufacturer listed as an Approved Manufacturer in this Section.

C. Provide dry type transformers whose performance under specified conditions is certified by the manufacturer.

D. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code”, and applicable portions NECA’S “Standard of Installation” .

F. ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE Standard including C2, “National Electrical Safety Code,” and C57.12.80, “Terminology for Power and Distribution Transformers.”

G. DOE 2016 LV Energy Efficiency levels as per DOE 10 CFR Part 431 – effective as of Jan. 1, 2016.

H. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.

I. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term “NRTL” shall be as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 TRANSFORMERS, GENERAL

A. Transformers: Factory assembled and tested, air cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for 60 Hz service.

B. Cores: All cores shall be constructed of high grade, grain oriented non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous windings without splices except for taps.

D. Internal Coil Connections: The core laminations shall be clamped together with structural steel angles. The completed core and coil shall then be bolted to the base of the enclosure by isolator from the base of the enclosure by means of rubber vibration-absorbing mounts. There shall be no metal-to- metal contact between the core and coil and the enclosure. The vibration isolation system shall be designed to provide a permanent fastening of the core and coil to the enclosure. Sound isolating systems requiring the complete removal of all fastening devices will not be acceptable.

E. Wiring compartment and termination shall be accessible by removing enclosure front panels.

F. The use of fans to obtain rated KVA or TP-1 rating shall not be permitted for all transformer types.

G. Transformer "K" rating shall be K-13.

H. The entire transformer enclosure shall be degreased, cleaned, phos-phatized, primed, and finished with a grey baked enamel.

I. The maximum temperature of the top of the enclosure shall not exceed 35˚C rise above a 40˚C ambient.

J. Transformers 15 KVA through 75 KVA shall be designed so they can be either floor or wall mounted. Above 75 KVA they shall be floor mounted, design except as noted on drawings.

2.2 GENERAL PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20 “Dry-Type” Transformers for General Applications.

B. Three phase transformers shall be 480 volt delta primary 208Y/120 Volt, 3-phase, 4-wire secondary unless otherwise noted. Other voltages shall be as shown on the drawings or otherwise required.

C. Windings: 2 winding type. Three phase transformers shall use one coil per phase in primary and secondary.

D. Provide aluminum windings.

E. Sound Level:
Sound levels shall not exceed NEMA ST-20 sound levels.

F. Each layer shall have end fillers, or tie downs, to provide maximum mechanical strength. Materials used shall have a minimum of one year of proven field usage. Insulation system shall be component recognized by Underwriter's Laboratories. The coils shall also have a final wrap of electrical insulating material to prevent mechanical injury to the wire as well as increasing the electrical breakdown strength. Coils with exposed wire will not be acceptable.

G. Transformers shall have the following features and ratings:

1. Enclosure: Transformers 25 KVA and larger shall be in a heavy gauge, sheet steel, ventilated enclosure. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code standards for ventilated enclosures. Outdoor transformers are to have rain-tight ventilation and a NEMA 3R rating.
2. Insulation Class: All insulating materials to be in accordance with NEMA ST-20 1972 standards for a 220˚C UL component recognized insulation system.
3. Basic Impulse Level: 10 kV for all 3-phase transformers.
4. Insulation Temperature Rise: Transformers 25 KVA and above shall be 115˚C temperature rise above 40˚C ambient unless otherwise noted. 115˚C rise in transformers shall be capable of carrying a 15% continuous overload without exceeding a 150˚C rise in a 40˚C ambient.
5. Taps: For transformer 3KVA and larger, full capacity taps in high-voltage winding as follows:
   a. 3 KVA through 30 KVA: Four 2.5% taps, two above and two below normal voltage.
   b. 30 KVA through 500 KVA: Four 2.5% taps, two above and two below rated normal voltage.
   c. 500 KVA through 1000 KVA: Four 2.5% taps, two above and two below rated normal voltage.
   d. Step-up to higher voltage transformers shall include +/- (1) tap AN and BN at the minimum percentage available based on the amount of primary turns.

H. Accessories: As follows:

1. Wall mounting brackets: Manufacturers standard brackets for transformers sized between 15 KVA and 75 KVA where wall mounting is indicated on drawings.
2. Core and coil assemblies 30 KVA and larger to be mounted on rubber vibration isolators on concrete pads.

2.3 NOISE ISOLATION TRANSFORMER (WHERE INDICATED ON THE ONE-LINE DIAGRAMS)

A. Transformers: Factory assembled and tested, air cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for 60 Hz service.

B. Coils shall use high grade magnet wire. Coils shall have clearly marked terminal pads attached to a rugged fiberglass termination strip. Windings shall have continuous wire wound construction and shall be vacuum impregnated with nonhydroscopic thermosetting varnish for superior strength and heat transfer. Each layer shall have end fillers, or tie downs, to provide maximum mechanical strength. Materials used shall have a minimum of one year of proven field usage. Insulation system shall be component recognized by Underwriter's Laboratories.

The coils shall also have a final wrap of electrical insulating material to prevent mechanical injury to the wire as well as increasing the electrical breakdown strength. Coils with exposed wire will not be acceptable.

C. Transformer shall have (2) 2.5 percent above nominal and (4) 2.5 percent below nominal universal full capacity taps.

D. Insulation system shall be UL Recognized at 220 degree C and shall be capable of continuous operation at 40 degree C ambient without windings exceeding 150 degree C temperature rise. Surface temperature rise shall not exceed UL 50 degree C limit. Wiring compartment temperature rise shall not exceed UL 35 degree C limit.

E. Floor mount enclosure shall be constructed of heavy gauge steel for indoor use. Weathershield kits shall be available to modify enclosures for NEMA 3R outdoor use.

F. Wiring compartment shall be sized for aluminum cable rated 125 percent of current, using long shanked crimp type connectors. Wiring compartment shall be accessible by removing enclosure front panel.

G. Vibration from core and coil assembly shall be isolated from enclosure by neoprene vibration pads and sleeves. A flexible copper grounding strap shall connect core to enclosure sized in accordance with applicable NEMA and NEC standards. A schematic connection diagram shall be located on enclosure nameplate for quick referral.

H. A premium electrostatic shield shall be included, consisting of a full width copper sheet placed between primary and secondary windings. Effective coupling capacitance shall be thirty picofarads. Average common mode noise attenuation shall be 120 db.

I. A rugged filter shall provide an average 60 db normal mode noise attenuation.

J. Surge suppression components shall be included to eliminate low voltage spikes and surges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall examine location where this equipment is to be installed, determine space conditions and notify Architect/Engineer in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Install equipment where shown, in accordance with manufacturer's written instruction, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

C. Coordinate with other work as necessary to harmonize installation of transformers with other equipment in the area.

D. Coordinate installation of transformers with cable and raceways installation work.

E. Arrange equipment to provide adequate spacing for cooling air circulation.

F. Identify transformers in accordance with Division 26 Section “Electrical Identification.”

G. Tighten electrical connectors and terminals in accordance with manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

H. Use flexible metal conduit to contain the conductors from the transformer to the raceway system.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches high and 2 inches larger in all directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 4000 psi compressive strength, and normal weight aggregate.

B. Anchor mounting hardware firmly to walls, floors, or ceilings to ensure enclosures are permanently and mechanically secured. Provide all hardware and accessories for proper mounting including vibration mounts designed to suppress transformer noise and vibration.

3.3 GROUNDING

A. Ground transformers and tighten connections to comply with torque tightening requirements specified in UL Standard 486A.

3.4 FIELD QUALITY CONTROL

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.

B. Thoroughly clean unit prior to making any tests.

C. Perform insulation-resistance test. Calculate dielectric absorption ratio and polarization index. Make measurements from winding-to-winding and winding-to-ground. Test voltages and minimum resistance shall be in accordance with Table below:

Minimum dc Test Voltage	Recommended Minimum Insulation Resistance in Megohms
1000 volts	500

D. Verify taps and connect transformer to desired tap, if applicable.

E. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

3.5 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt and construction debris. Touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION

SECTION 26 24 15

SERVICE ENTRANCE SWITCHBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Provide all switchboard, and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and as specified herein.

B. Wires/cables, busses, electrical boxes and fittings, and raceways required in conjunction with the installation of switchboard, and enclosures are specified in other Division 26 sections.

C. All switchboards, panelboards, switchgear, transformers, disconnect switches, starter, etc., shall be fabricated by same manufacturer throughout the entire project.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on switchboard and enclosures.

B. Wiring Diagrams: Submit wiring diagrams for switchboard showing connections to electrical power service and feeders.

C. Submit electrical room plan, view drawings at ¼" scale with all electrical equipment, end and front elevation views of switchboard showing circuit breakers and ratings, buss work, conduit areas, dimensions, recommended housekeeping pad sizes, mounting of equipment supplied.

D. The equipment product data, main electrical room layout and short-circuit and coordination studies shall be submitted together in order to provide proper evaluation.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of switchboard and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for no less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects utilizing switchboard similar to those required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC as applicable to installation, and construction of switchboard and enclosures.
2. UL Compliance: Comply with applicable requirements of UL 50, 869, 486A, 486B, 891, 1053, and 1066 pertaining to switchboard accessories and enclosures. Provide switchboard unit which are UL-listed and labeled.

3. NEMA Compliance: Comply with NEMA Stds Pub/No. 250, “Enclosure for Electrical Equipment (1000 Volts Maximum),” and Pub/No. PB 1.1, “Instructions for Safe Installation, Operation and Maintenance of Equipment Rated 600 Volts or Less.”

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store switchboard in a clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.

B. Handle switchboard carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of switchboard, and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 SWITCHBOARD

A. The switchboard shall be designed, manufactured and tested in accordance with applicable standards of NEMA, ANSI, and IEEE. The enclosure shall be completely self-supporting, front and rear angle forming a single metal enclosed structure. The side, top and rear covers shall be code gauge steel and finished with medium gray (ANSI #61 or #49) paint applied over rust inhibiting phosphate primer. Frame structure members shall be die-formed, 11-gauge steel bolted together and reinforced at corners. Switchboard frames are to be suitable to be bolted to floor sills embedded in concrete. The equipment shall be totally adjusted and tested at the factory and sectionalized for shipment so that the largest section does not exceed 49 inches wide, 60 inches deep, and 90 inches high to enable installation at the job site.

B. The switchboard shall be provided with load and line side compression or mechanical lug terminations for incoming and outgoing cables.

C. All switchboard bussing, devices, and connections shall be braced to withstand the maximum short circuit current available from the utility transformer. The switchboard shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, switchboard main disconnect(s), and switchboard branch circuit devices. The short circuit current rating of the switchboard(s) shall exceed the available short circuit, and be not be less than 65,000 RMS symmetrical amperes. The switchboard branch circuit devices short circuit current rating shall be fully rated, and exceed the available short circuit..

D. The switchboard through-buss shall be silver-plated copper. The switchboard bussing shall be of sufficient cross sectional area to meet UL Standard 891 for temperature rise. The through-buss shall have an ampacity rating as indicated on one-line drawings and extended the full length of the switchboard. The through-buss shall be 100% rated. Provisions shall be provided for future splicing of additional sections. The neutral buss shall be 100% rated.

E. The switchboard distribution section buss shall be of the same material as the through-buss and shall be fully rated. The distribution section neutral plate shall be of copper provided with Cu/Al lugs for the devices installed and future specified devices.

F. A copper 1600A, (2) 0.25 x 3-inch ground buss shall be secured to each vertical section structure. Ground buss shall extend entire length of switchboard and shall be equipped with a terminal accommodating up to 250 Kcmil for connection to purchaser’s ground system. A lug strap shall be provided for each vertical feeder section.

G. Switchboard shall be separated into shipping blocks. Each switchboard section shall be capable of being handled individually with the use of removable lifting bars or rollers and be clearly labeled with proper handling procedures.

H. Switchboard shall be arranged for connection to the supply source by cable with UL service entrance label, incoming line isolation and shall have side barriers between sections.

I. Overcurrent compartment doors shall be secured with two captive hex head screws.

J. Provide cable supports for each vertical section.

K. Bolted covers that can be bolted closed shall be provided for each cable compartment. Utility CT sections shall not be provided with hinged doors.

L. Provide shutters in drawout breaker compartments to cover breaker primary line and load disconnects when the breaker is removed from the compartment.

M. Cable bending space shall meet National Electrical Code requirements. All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.

N. A-B-C buss arrangement (left-to-right, top-to-bottom, front-to-rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, buss bars shall be labeled.

O. Breaker primary connections shall be copper-to-copper, silver-plated on drawout breakers, silver-plated on stationary breakers.

P. All feeder device line and load connections shall be rated to carry continuous current rating of device frame (not trip rating).

Q. A utility metering compartment shall be supplied to meet requirements of the Central Hudson Gas and Electric Company. No additional cost to the Owner will be allowed for coordinating and meeting the local utility company requirements.

R. Service Entrance shall comply with UL Service Entrance requirements: Service entrance label, incoming line isolation barriers, neutral connection to switchboard ground for solidly grounded wye systems. The switchboard shall be listed as suitable “For Use” as service entrance and not as “Only” for service entrance. The Neutral-Ground bond shall be capable of being isolated in the future.

S. Incoming Line Section shall be rated as indicated in drawings. Main cable connection as shown on drawing.

2.2 CIRCUIT BREAKERS

A. Main Breakers:

1. The circuit breaker shall be fixed mounted type with the frame and rating (100%) size as shown on the associated drawings. The breaker operating mechanism is to be of the two-step stored energy quick-make, quick-break type. First step operation of local “close” button is to close the breaker contacts. Closing of the breaker contact shall automatically charge the opening springs to insure quick-break operation. The trip unit shall be provided with adjustable long time, short time, instantaneous and ground fault trip functions. It shall also be provided with kirk-key interlocks.
2. Main protective devices shall be low voltage insulated case circuit breakers. All protective devices shall be UL 489 listed.
3. Provide Ground Fault sensing and tripping.
4. Moveable Element: Breakers shall have manual trip button and position indicator. “Push to Close” button shall be located on front of breaker for easy access. Breaker shall be able to have all 3 primary breaker

contacts padlocked in open position to prevent unauthorized breaker closing. In Test and connected positions, breaker element shall have positive ground to housing. Breakers with same frame sizes shall be interchangeable.

B. Feeder Circuit Breakers

1. Feeder circuit breakers shall be 100% rated, molded case circuit breakers with solid state (microprocessor) trip unit. The breaker shall be manually operated type frame and be stationary mounted. Line and load side circuit breaker connections are to be buss type. The trip unit shall be provided with adjustable long time, short time, instantaneous and ground fault trip functions. Provide metering capabilities per paragraph 2.3.
2. Provisions for all controls, future accessories and communications shall be factory wired.
3. Breakers shall be suitable for reverse feeding.

2.3 POWER MONITORING EQUIPMENT

A. Circuit Breaker Monitor: The feeder circuit breaker shall have a fully functioning microprocessor based circuit monitoring device (CMD) for measuring true RMS currents and voltages. The CMDs shall have a display meter with an easy to use, full-function, electronic meter. The metering values shall be phase selectable, include RMS current for each phase and neutral, Voltage (L-L and L-N), Watts, VARs, Volt-Amps, Power Factor, Watt-Hours, VAR Hours, Volt-Amp hours, Current Demand, Peak Current, Watt Demand, Peak Watts Demand, Peak VARs Demand, VARs Demand, Peak volt-amperes Demand, volt-amperes Demand, Q-Hours, Power Factor Average, Power Factor during last demand and interval and Frequency. The breaker-mounted solid-state device shall have a single-line LCD display visible front of switchboard. All monitoring devices in each switchboard shall be tied into central monitor located above the main breaker.

B. Central Monitor: The Monitor shall be provided on specified circuits. This panel mounted solid state device shall have an LCD display with 2 lines, 16 characters each. The device shall provide the functions listed below.

1. Metering values available for display at the monitor shall include RMS current for each phase, RMS voltage (L-L or L-N), Watts, VARs, Volt-Amps, Power Factor, Watt-hours, Watt demand, and frequency from each of the CMD devices.
2. Events shall be defined by the devices that are connected to the Central Monitor. Events shall include circuit breaker trips such as overvoltage, undervoltage and ground fault. When an event occurs, the event log shall be updated with the device alphanumeric name and type of event.
3. The New Event indicator light shall notify the user of the existence of a new event (if enabled during setup). A relay contact shall also operate (if enabled during setup) which shall allow the user to use other types of event notification, such as an audible alarm.
4. The device shall permit the user to define a password to provide security protection. The device setup and all user defined values/settings shall be accomplished by entering the information into the device via the four digit keypad on the front of the faceplate.
5. The device shall be capable of communicating on the FUTURE communication network.

2.4 TRANSIENT VOLTAGE SURGE SUPPRESSOR

A. Each switchboard shall be provided with a Transient Voltage Surge Suppresser (TVSS) exterior of enclosure, and shall be UL 1449 Listed and CSA Approved. The TVSS shall meet the requirements of Section 26 43 13 for service entrance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area and conditions under which switchboards, panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SWITCHBOARD

A. Install switchboards, panelboards, and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation," and in compliance with recognized industry products fulfill requirements practices to ensure that.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Std 486A and B.

C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

D. Provide properly wired electrical connections for switchboard.

E. Provide engraved, plastic laminate labels for all switchboard indicating name, voltage, phase, wire and short circuit rating. In addition, each branch device on the switchboard shall be labeled (engraved). Refer to Section 26 05 53 for more information.

F. Provide typed panelboard's circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

3.3 RISER DIAGRAMS PLACARD

A. Provide an electrical riser diagram for light and power, telephone, fire alarm and smoke detector, and emergency power framed, under glass, and mounted on the wall in the transformer room. Prints shall be of the diffusion transfer process to eliminate fading.

3.4 SWITCHBOARD BASES

A. Construct concrete equipment pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches high and 2-inches larger in all directions that the overall dimensions of the supported unit. The highest switch shall not exceed 6'-6" above the floor when installed on the pad.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Install reinforcing bars, channel sills embedded into concrete to tie to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use cement conforming to ASTM C 150, 4000 psi compressive strength, and normal weight aggregate.

3.5 GROUNDING

A. Provide equipment grounding connections for switchboard enclosures as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL 486A to assure permanent and effective grounds.

B. Refer to Section 26 05 26 for additional grounding requirements.

3.6 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment."

A. Infrared Inspection (After Energized):

1. The scan is to include all electrical switchboard field connections to buss bars and loads.
2. All equipment should be energized at normal load levels for at least 1 to 2 hours prior to being scanned.
3. Access covers are to be removed and reinstalled by the electrical contractor for the Engineer to inspect and scan all electrical junctions, buss, and cable.
4. The IR Scan will be made using an AGEMA 720 camera. The camera shall provide infrared photos clearly indicating problem areas.
5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and Polaroid pictures of all problem areas.

B. Switchboard:

1. Visual and mechanical Inspection:
   a. Inspect for physical damage and code violations.
   b. Inspect for proper alignment, anchorage and grounding.
   c. Inspect for proper identification of protective devices and switches.
   d. Check tightness of accessible bolted buss joints.
   e. Physically test all electrical or mechanical interlocks to assure proper function.
   f. Clean interior and insulator surfaces.
   g. Inspect for proper operation of space heaters and thermostat settings (if they exist).
2. Electrical Tests:
   a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
   b. Check switchboard for electrical continuity of circuits and for short circuits.

C. Circuit Breakers:

1. Visual and Mechanical Inspection:
   a. Inspect for physical damage.
   b. Mechanical operational test will be made in accordance with manufacturer's instructions.
   c. Check tightness of all hardware connections.
   d. Check cell fit and element alignment.
2. Electrical Tests:
   a. Measure contact resistance.
   b. Check the following functions by primary current injection.
      1) Measure minimum long-time pickup when possible.
      2) Measure long-time delay at three (3) times long-time pickup current.
      3) Measure short-time pickup.
      4) Measure short-time delay at 1½ times short-time pickup current.
      5) Measure instantaneous pickup.
      6) Measure ground fault pickup.
      7) Measure ground fault delay at 1½ times ground fault pickup.
      8) Check trip unit reset operation.
   c. Perform insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
   d. Metering and instrumentation
      1) Visual and mechanical inspection.
         a) Check all devices for physical damage and connection tightness.

b) Verify meter nameplate designation.

e. Electrical Tests
1) Check calibration of all panel meters at zero, mid-scale and full-scale deflections by transfer standard.
2) Check calibration of watt-hour meters for proper registration by use of rotating standard at light, heavy, and 50% power conditions.
3) Verify all instrument multipliers and scale factors.

3.7 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.8 DEMONSTRATION

A. Subsequent to wire and cable hook-ups, energize switchboard and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles
2. Ground Fault Circuit Interrupter Receptacles
3. Plugs
4. Plug Connectors
5. Snap Switches
6. Dimmer-Switches
7. Wall Plates

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 26 Section “Disconnects, Fuses and Enclosed Breakers” for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

1.3 SUBMITTALS

A. Product data for each type of product specified. Include a color selection chart showing available color for each device type.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following codes.

1. NFPA 70 “National Electrical Code.”

B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

1.5 SEQUENCE AND SCHEDULING

A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.

B. Color of Devices: Color of all devices shall be coordinated with the Architect, except special purpose devices shall be black, emergency power system devices which shall be red, corrosion-resistant devices which shall be yellow, surge suppression devices shall be blue, or isolated ground devices which shall be orange.

C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 5.

D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

E. All receptacles fed from emergency generator power upon normal power failure, shall be "Hospital Grade" type. Cover shall be steel with red baked enamel. Receptacles connected to emergency power shall be colored red and durably marked to indicate panelboard and circuit number supplying them.

F. Ground-Fault Interrupter (GFI) Receptacles: As scheduled in Tables 1 and 2 in Part 3 indicated herein: Provide “terminal” or feed-through type ground-fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943.

G. All single receptacles or multi-outlet receptacle assemblies in lab areas shall be labeled with panel and circuit breaker.

H. All non-locking 125-volt, 15A and 20A receptacles in guest rooms and guest suites in hotels and motels shall be listed tamper-resistant type.

I. All 15A and 20A, 125V and 250V, non-locking receptacles located in damp or wet locations shall be listed weather-resistant type.

J. Provide Firestop putty pads on the backside of all boxes exceeding 16 sq. inches in area. Provide Firestop putty pads on the back side for all outlet boxes within 24 inches of each other, in opposite sides, and at same elevation, in the same wall. Provide Firestop putty pads on the back side for all boxes in a wall or ceiling where the aggregate surface area of the outlet boxes exceeds 100 sq. inches per 100 sf of surface of wall or ceiling area. Firestop putty pads shall be Hilti CP617XL (9” x 9”) for each box 16 sq inches or less.

K. Snap Switches: As scheduled in Table 3 in Part 3 indicated herein:

L. Wall Dimmer: As scheduled in Table 3 in Part 3 indicated herein.

1. Wall dimmers shall be solid state type with slide control handle, preset button and semi-flush mounting. Dimmers shall be sized to continuously carry the load they are connected to, the minimum size shall be 1000 watts, and shall be rated larger if indicated on the drawings or required to serve the load.
2. Dimmers shall be selected to match the specific load served.
3. All dimmers shall be of the same manufacturer. Faceplate shall be the same color as device plates specified.

M. Vacancy Sensors: See Section 26 51 01.

N. Floor Outlets: Floor boxes shall be concealed service, fully adjustable cast iron, watertight type for single or multi-gang installations. Floor box shall have space for both 120 volt and telecommunication wiring. Service fittings, covers, and accessories shall be brass. Service fittings shall be in floor flush type with outlet devices as indicated on the drawings. Provide covers, extensions, adapters and necessary components to provide the service type indicated on the drawings. Install carpet flange on all outlets in carpeted areas.

O. Floor Poke through Outlets: The device shall be a fire-rated poke-through with a flush service fitting shall be UL classified with a fire rating that is the same as the floor in which the outlet is installed. The units shall accommodate power, telephone and data services in a single unit, or multiple units as shown on the documents. The poke-through shall be pre-wired and install in a 4 inch diameter core drilled hole. The internal spur assembly is designed so that the pedestal is secure in place from above, while also allowing for easy removal or relocation data jacks and power. Receptacles shall be covered by lift cover flaps that lay flat against the cover when open. Modular jacks include dust covers. Poke-through shall be a Hubbell S1PT series or approved equal.

P. Surface Mounted Multi-outlet System:

1. Multi-outlet system shall consist of surface mounted all steel raceways for use with number and type of wiring devices installed as shown on the Drawings. System shall be complete with all fittings required for a complete installation.

    a. Wiremold 4000 Series - Raceway with buff finish shall be 4-3/4" high by 1-3/4" deep with dividers deep and snap on cover and shall contain brackets for mounting of grounding type wiring devices located 12" on centers and rated 20 amperes, 120 volts, unless otherwise indicated on drawings.
    b. Wiremold 3000 Series - Raceway with buff finish shall be 2-3/4" high by 1-15/32" deep with snap on cover and shall contain brackets for mounting of grounding type wiring devices located 12" on centers and rated 20 amperes, 120 volts, unless otherwise indicated on drawings by symbol, and having the capability of being installed wherever desired within the raceway. All branch circuit wiring shall be run within the raceway.
    c. Wiring devices shall be as specified under "Outlet Boxes and Wiring Devices" with plates having finish to match that of multi-outlet system raceway. Each receptacle cover shall be indent stamped with the voltage and ampere rating of that receptacle.
    d. All receptacles in multi-outlet assemblies shall be labeled with panel and branch circuit number.

Q. Wireways:

1. Wiring troughs shall be 4" x 4" or 6" x 6", brake-formed of code gauge steel, furnished in standard 10-foot sections with knock- outs, as required. Wiring troughs shall be of the screw cover type and shall have a high grade enamel finish baked on a chemically-cleaned and zinc-phosphatized surface providing maximum resistance to corrosion.
2. Wiring troughs shall be furnished with all the required components, such as square junction boxes, 90-degree elbows, T-shaped pull boxes, crossover pull boxes, box-connecting couplings, fittings and screw-on cover plates. Lengths of individual sections shall be provided in accordance with installation requirements.

R. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFI type or GFI protected and have “in use” covers.

S. All devices shall be premium specification grade.

2.2 WIRING DEVICE ACCESSORIES

A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated on drawings. Engraving shall be done by the device manufacturer. All lettering shall be 1/8-inch high and shall be black for normal power systems and red for emergency power systems. Provide

plates possessing the following additional construction features:

1. Material and Finish: 0.04 inch thick, type 302 satin finished stainless steel. Plate shall be Hubbell “S” Series or approved equal.
2. Surface mounted wiring devices and blank outlet plates shall be cadmium plated. Interior outlet plates shall be pressed steel. Outlets exposed to weather or corrosive conditions shall be of the cast-metal type.
3. Plates for weatherproof receptacles shall consist of cast- aluminum gasketed plate with spring-loaded lift covers providing access to the outlet. Lift cover to correspond to number of outlets to be gasketed. Plates for weatherproof switches shall consist of a cast plate with flexible bubble for activating a push type switch. Plates shall be for corrosion-resistant devices, as manufactured by Hubbell, Inc., or approved equal.

B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device plates shall be cast type with gasketing to prevent entrance of moisture when closed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine location where wiring devices and installation components are to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

A. Install wiring devices and accessories as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.

C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.

D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.

E. Electrical outlets shall be installed vertically unless otherwise noted. Those located on interior columns shall be centered laterally.

F. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.

G. Install wall switches on the strike side of doors.

H. Mount switches with the long dimension vertical and the operating handle in the upward position when in the "On" position.

I. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.

J. Provide a current carrying conductor, neutral, equipment grounding conductor and an insulated grounding conductor to each isolated ground “IG” receptacle.

K. Install galvanized steel wall plates in unfinished spaces.

L. Install wiring devices after wiring work is completed.

M. Install wall plates after painting work is completed.

N. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for wiring devices. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

O. At time of completion, replace items which have been damaged including those burned and scored by faulty plugs.

P. Where it is not possible to set the switch box flush with the wall, furnish raised edge plates.

Q. Where more than one switch is being installed, provide multiple gang switch plates for number of switches as required.

3.3 PROTECTION

A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.4 FIELD QUALITY CONTROL

A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.

B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

C. TABLE 1

RECEPTACLES

Designation (1)	Current Rating Amps	Voltage Rating	Single/ Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL2162	-
-	20	125	Single	5-20R	HBL5361	-
IG	20	125	Duplex	5-20R	IG5362	Isolated Ground
WP	20	125	Duplex	5-20R	HBL5362WR	Weather-proof (4)
GFI	20	125	Duplex	5-20R	GF20LA	Integral GFI (2)
SS	20	125	Duplex	5-20R	5362S	Surge Suppression
TP	20	125	Duplex	5-20R	DR20TR	Tamperproof
CH	15	125	Simplex	5-15R	HBL5235	Clock Hanger

NOTES

1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.
3. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.
4. Where required per NEC or local code provide 'WP26M' in-use water-proof cover.

D. TABLE 2

NOT USED

E. TABLE 3

SNAP SWITCHES/WALL DIMMERS

Designation (1)	Typical Application	Load Rating	Voltage Rating (AC)	Poles	Hubbell Catalog #(4)	Notes
S	Control Lights	20A	120/277	1	DS120	-
S3	Control Lights	20A	120/277	3-way	DS320	-
S4	Control Lights	20A	120/277	4-way	DS420	
Sp	Switch & Pilot Light	20A	120/277	1	DS1201	(2)
D	Dimmer Switch	1000W	120	1	Vareo Series w/preset	(3)
Sk	Key Switch	20A	120/277	1	HBL1221L	
Swp	Wp Switch & Cover Plate	20A	120/277	1	1281/1750	

NOTES

1. For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
2. Pilot light "on" when switch is "on."
3. Lutron dimmer (refer to 26 05 05 for additional manufacturers). Provide dimmer wattage size to handle load served. Derate dimmer switch per manufacturer's recommendations where dimmers are ganged together.
4. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.).

END OF SECTION

SECTION 26 28 16

DISCONNECTS, FUSES AND ENCLOSED BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Materials and Methods sections, apply to work of this section.

1.2 SUMMARY

A. Provide all circuit and motor disconnect switch and circuit breaker work including fusing, electrical connections to motors, appliance and mechanical equipment as indicated on the drawings and schedules.

B. All disconnects serving smoke fans/motors shall have auxiliary contact wired to control circuit of upstream starter/VFD to monitor the position of the disconnect.

C. Types of circuit and motor disconnect switches in this section include the following:

1. Equipment disconnects.
2. Appliance disconnects.
3. Motor-circuit disconnects
4. Enclosed breakers.

D. Applications of electrical power connections specified in this section include the following:

1. To resistive heaters.
2. From electrical source to motor starters.
3. From motor starters to motors.
4. To lighting fixtures.
5. To converters, rectifiers, transformers, inverters, rheostats, and similar current adjustment features of equipment.
6. To grounds including earthing connections.
7. To panelboards, contactors, time clocks and similar equipment.

E. All switchboards, panelboards, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches, fuses, equipment connectors.

B. Fuse Product Data: For each type of fuse indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings:

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.

b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Fuse sizes for elevator feeders and elevator disconnect switches, and circuit breakers.

1.4 QUALITY ASSURANCE

A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 02 titled "Electrical Requirements".

B. "Manufacturers" - Firms regularly engaged in manufacture of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less than 5 years.

C. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.

D. Comply with NEC (NFPA 70) for construction and installation of safety and disconnect switches.

E. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.

F. NEMA Compliance: Comply with applicable requirements for NEMA Stds Pub/No. KS 1, "Enclosed Switches," and No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

G. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."

H. NEMA Compliance: Comply with NEMA FU1 for cartridge fuses.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C)or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

B. Molded case circuit breakers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:

1. UL 489 – Molded Case Circuit Breakers
2. NEMA AB1 – Molded Case Circuit Breakers
3. NEMA 250 – Enclosures for Electrical Equipment

PART 2 - PRODUCTS

2.1 CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. Furnish and install safety switches as required for motor outlets or other equipment. Switches shall be of size, number of poles, and fused or non-fused, as required for job conditions and the National Electrical Code.

B. Switches shall be equipped with fuse contacts and jaws which ensure positive fuse and jaw contact by means of reinforcing spring clips of other approved means. All current carrying parts shall be silver-plated. Hinges shall be non-current carrying. Switches shall be so designed that they can be locked in either open or closed position.

C. All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. 30A thru 100A switches shall have provisions for field installed fuse pullers. Switches shall include solid neutral where required.

D. All safety switches shall be NEMA 1 enclosed Type “HD” (heavy duty) quick-make, quick-break, and have interlocking cover with handle that may either be front or side operating with padlocking provisions. Provide NEMA 3R weather proof enclosures where indicated on the drawings or exposed to exterior or damp locations. Incorporate rejection clips where used with Class “R” fuses.

E. Handle position shall indicate if switch is ON or OFF. Handle shall have provision for padlock.

F. Switches shall be rated for voltage, poles, amperes, and horsepower, as required or shown on Drawings. All switches shall be rated for maximum available fault current as required or shown on Drawings.

G. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated on drawings. See Section “2.3” for Fuse specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.

H. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated on drawings.

I. Double-Throw Switches: Heavy duty switches of classes and current rating as indicated on drawings.

J. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977; single or double-throw arrangement as indicated. For fusible units provide fuses as indicated on drawings.

K. Accessories:

1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated on drawings or specified elsewhere in specifications.
2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated on drawings to be NEMA 4X:
   a. Stainless Steel Type 316.
   b. Heavy case aluminum.
3. Captive Fuse Pullers: Provide built-in pullers arranged to facilitate fuse removal.

2.2 CONNECTIONS FOR EQUIPMENT

A. General: For each electrical connection indicated provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts. All other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. General: Provide metal conduit, tubing and fitting of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 26 05 06 titled “Basic Materials and Methods” and Section 26 05 33 titled “Raceways and Boxes” and in accordance with the following listing of metal conduit, tubing and fittings:

    a. Rigid steel conduit.
    b. Rigid metal conduit fittings.
    c. Electrical metallic tubing.
    d. EMT fittings.
    e. Flexible metal conduit.
    f. Flexible metal conduit fittings.
    g. Liquid-tight flexible metal conduit.
    h. Liquid tight flexible metal conduit fittings.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables and connectors complying with Division 26 05 06 titled “Basic Materials and Methods” and “Section 26 05 19” titled “Wires and Cables.”
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and rating, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended for use by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 FUSES

A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics, which comply with manufacturer’s standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

B. Class RK1 dual element time-delay fuses: Provide UL Class RK1 current limiting time-delay fuses rated 600-volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors and panelboards.

C. Class RK5 dual element time-delay fuses: Provide UL Class RK5 current limiting time-delay fuses rated 600 volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors, and transformers.

D. Class L time-delay fuses: Provide UL Class L time-delay fuses rated 600 volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.4 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted NEMA-1 steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified in Section 3.3 with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.

3. Provide engraved, plastic laminate label “Spare Fuses” for cabinet. Refer to Section 26 05 53 for more information.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

B. A complete set of spare fuses shall be purchased at the same time the initial fuses are purchased. Spare fuses shall consist of a standard carton for 0 to 60 amperes rating, and for above 60 amperes rating provide 10% of each type and rating or a set of three, whichever is greater. Spare fuses shall be placed in one or more spare fuse cabinets as required. The spare fuse cabinet shall be 30” H x 24” W x 12” D with key lock door, center shelf and fuse index holder. Include one set of fuse bulletins in the fuse cabinet.

C. Fuses shall be U.L. Class L, time-delay and shall employ “O” rings as positive gas seals between the end bells and the glass melamine fuse barrel. Mounting terminals shall be opened. Fuses shall be time-delay and must hold 500% of rated current for a minimum of 4 seconds and clear 20 times rated current within .01 seconds. Fuse links shall consist of pure copper.

2.5 MOLDED CASE PROTECTIVE DEVICES

A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

D. The Contractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

2.6 ENCLOSURES

A. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 surface of flush-mounted general purpose enclosures intended for indoor use.

B. All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.

C. Provide handle mechanisms that are pad-lockable in the “OFF” position.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine location where fuses and safety and disconnect switches and circuit breakers are to be installed and notify Architect/Engineer in writing of conditions detrimental to proper and timely/completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated. For all disconnecting means located remote from the motor controller (starter or variable frequency drive), contractor to provide disconnect with auxiliary contacts, contacts and control wiring back to motor controller.

D. Provide NEMA 3R disconnect switches for all exterior locations and any location subject to moisture.

E. Provide box with spare set of each size fuse used on job.

F. Provide nameplate on switch, indicating equipment served.

G. Provide line voltage wiring from starter/VFD control circuit to Aux contact in disconnect. Provide 2# 10, 3/4" C or run with power wire if same voltage.

3.3 INSTALLATION OF EQUIPMENT CONNECTIONS

A. Install electrical connections in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "nicking" copper conductors while skinning wire.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.

H. Provide PVC-coated conduit and fittings for highly-corrosive atmospheres.

I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensation can be expected to accumulate.
3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease, or water.

K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section titled “Electrical Identification.” Affix markers on each terminal conductor, as close as possible to the point of connection.

L. Provide flexible metal conduit or Type “S” rubber cords, pigtails, caps, etc., as required to constitute an operating system. All flexible cords shall have a grounding conductor. Ground all equipment. See Section 26 05 26 titled “Grounding” for additional requirements.

M. Prior to roughing-in, refer to all equipment manufacturer’s shop drawings for details of equipment connections. Provide receptacles as required to match the cord caps on the equipment furnished. Provide either direct wiring or receptacles for final connection to equipment as required for the particular equipment furnished regardless of the type of outlet shown on the plans.

3.4 INSTALLATION OF FUSES

A. Install fuses as indicated, in accordance with manufacturer’s written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.

B. Coordinate work including electrical wiring, as necessary, to interface installation of fuses with other trades.

C. Install fuses in fused switches.

D. Provide spare fuse cabinet located in each main switchgear room. Provide spare fuse of size and type for every five (5) fuses installed. A minimum of three (3) spare fuses shall be provided for each size installed.

E. Contractor shall install Class R fuse rejection kits on all heavy duty safety switches not already fitted for Class R fuses.

3.5 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS

A. Install enclosed circuit breakers as indicated, complying with manufacturer’s written instructions, applicable requirements of NEC, NEMA, and NECA’s “Standard of Installation,” and in accordance with recognized industry practices.

B. Coordinate enclosed circuit breakers installation work with electrical raceway and cable work, as necessary for proper interface.

3.6 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical disconnect switches.

3.7 FIELD QUALITY CONTROL

A. Testing: Subsequent to completion of installation of electrical disconnect switches and circuit breakers, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

B. Upon completion of installation of fuses, test and inspect system to ensure compliance with requirements.

C. Final tests and inspections of fuses shall be made prior to energization of the equipment. This shall include a thorough cleaning, tightening and review of all electrical connections and inspection of all grounding conductors.

END OF SECTION

SECTION 26 29 13

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of motor controller work is indicated by drawings and schedules.

B. Types of motor controllers specified in this section include the following:

1. Combination.
2. Fractional HP manual.

C. Work of this section includes wires/cables, raceways, electrical boxes and fittings, as specified in Division 26 sections, and used in conjunction with motor controllers.

D. Refer to applicable Division 26 sections for wires/cables, electrical raceways, and boxes and fittings required in connection with motor controllers.

E. All motor controllers, switchboards, panelboards, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the project.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions or motor controllers.

B. Shop Drawings: Submit shop drawings of motor controllers showing accurately scaled equipment locations and spatial relationships to associated motors and equipment.

C. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers showing connections to electrical power panels, feeders, and equipment. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of motor controllers of types and sizes required, whose products have been in satisfactory use in similar service for no less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience with projects utilizing motor controller work similar to that required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.
2. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
3. UL Compliance: Comply with applicable requirements of UL 486A and 486B, and components which are UL-listed and labeled.
4. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to motor controllers.
5. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," pertaining to motor controllers and enclosures.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver motor controllers and components properly packaged in factory-fabricated type containers.

B. Store motor controllers and components in original packaging and in a clean dry space; protect from weather and construction traffic.

C. Handle motor controllers and components carefully to avoid breakage's, impacts, denting and scoring finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceway, to properly interface installation of motor controllers with other work.

B. Sequence motor controller installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.7 MAINTENANCE

A. Maintenance Data: Submit maintenance data and parts list for each motor controller and component; including "troubleshooting" maintenance guide. Include that data, product data and shop drawings in a maintenance manual; in accordance with requirements of Division 1.

B. Maintenance Stock, Fuses: For types and rating required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units each.

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLERS

A. General: Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

B. Combination Controllers: Provide full-voltage alternating-current combination nonreversing controllers. Controllers shall consist of variable frequency drivers or motor circuit protector and disconnect switch mounted in common enclosure, of types, sizes, rating, and NEMA sizes shown on drawings. Each starter shall have a 120-volt, 60 Hz,

control power transformer, H-O-A selector switch, red run pilot light, single phase protection and (2) two sets of N.O. and N.C. contacts for the building automation system. Equip controllers with block type manual reset overload relays and with fusible disconnect switches. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with three padlocks. Construct and mount controllers and disconnect switches in single NEMA Type 1 enclosure; coat with manufacturer's standard color finish. Provide NEMA 3R where installed in an exterior or damp location.

C. Provide start time delay relay with range 0-300 seconds for all motors 10 HP and larger. Set each relay 4 seconds apart for sequenced start-up after loss and restoration of normal power.

D. Fractional HP Manual Controllers: Provide single-phase fractional HP manual motor controllers, of sizes and ratings shown on drawings. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Controller to become inoperative when thermal unit is removed. Provide controllers with double break silver-alloy contacts, visible from both sides of controller; green pilot lights, and switch capable of being padlocked OFF. Enclose controller unit in NEMA Type 1 general purpose enclosure; coat with manufacturer's standard color finish. Provide NEMA 3R where installed in an exterior or damp location.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which motor controllers are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MOTOR CONTROLLERS

A. Install motor controllers in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to ensure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque requirements specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

A. Prior to energization of motor controller equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, check circuitry for electrical continuity, and for short circuits.

C. Ensure that direction of rotation of each motor fulfills requirements.

3.4 GROUNDING

A. Provide equipment grounding connections for motor controller equipment. Tighten connections to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounding.

3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms, where necessary, for free mechanical movement.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.6 DEMONSTRATION

A. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

END OF SECTION

SECTION 26 31 00

PERFORMANCE SPECIFICATIONS

SOLAR PHOTOVOLTAIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provision of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. The provisions of this article apply to solar photovoltaic electrical energy systems, including the array circuit(s), inverter(s), and controller(s) for such systems. Solar photovoltaic systems are interactive with other electrical power production sources. These systems have AC output for utilization.

B. The following are parameters associated with the PV system that should be adhered to:

PV System Overall Wattage	50kW
PV System Output Voltage	480V, 3-phase (60 Hz)
PV Panel Output Wattage (W/sqft)	15W/sqft
DC/AC Conversion Efficiency	95%
PV Panel Efficiency	16%
PV Panel Mounting	Roof (Fixed)
PV Panel Tilt (deg)	36º
PV Panel Azimuth (deg)	202.5º
PV Panel Inverter	Integral

Approved list of manufacturers is as follows: SunPower, LG, REC Group, Panasonic, Solartech Universal

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on all photovoltaic modules and components. Include manufacturer's standard product warranty, for duration of not less than 25 years, for replacement of materials and equipment used in photovoltaic systems.

B. Shop Drawings: The Contractor shall submit copies of pertinent drawings and schematic diagrams for approval and shall include the following:

1. Photovoltaic system plans and elevations or riser views clearly indicating entrance points for each of the interconnections required.
2. Electrical schematic diagrams including all wiring, conductors, disconnects, switches, grounding, and utility inter-tie locations.
3. Diagrams including wire sizing with respect to DC and AC voltage, wattage and amperage.
4. Legends for all devices on all diagrams.
5. A complete ½" = 1'-0" scale drawing showing the exact photovoltaic system layout including all components and accessories being provided or required for operation as specified herein.
6. Main circuit breaker.

C. Wiring Diagrams: Submit wiring diagrams for photovoltaic showing connections to electrical power panels, feeders, automatic transfer switches, disconnects, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

D. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit 4 copies of an agreement for continued service and maintenance of photovoltaic systems, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

E. Provide photovoltaic system certified test record of the final production testing.

F. Provide certified test record prior to photovoltaic component set being shipped from factory to project location. This includes certified test record of photovoltaic modules, inverters and associated equipment.

1.4 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of photovoltaic modules and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with grid-tied photovoltaic systems similar to that required for this project.

1. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of diesel engine-driven generator units.

C. Photovoltaic System Supplier Qualifications: Photovoltaic System supplier shall be factory-authorized distributor nearest to the project location for the system being provided. There shall be a distributor for the generator manufacturer within a driving distance of 50 miles. Supplier shall certify that they employ at least two technicians who have attended all factory service schools. Supplier shall certify that they offer 24-hour, 7-day field service and maintain the manufacturer's recommended parts inventory on all field service vehicles, as well as a complete recommended service parts stock at their location nearest the project.

D. Codes and Standards:

1. Electrical Codes Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 690 and 705 pertaining to construction and installation of solar photovoltaic systems and interconnected electrical power production sources.
2. NFPA Compliance: Comply with applicable requirements of NFPA 37 and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures".
3. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches," UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL 486B, "Wire Connectors for Use with Aluminum Conductors."
4. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1 "Motors and Generators," and MG 2, "Safety and Use of Electric Motors and Generators".

E. NEMA Compliance: Comply with applicable requirements of NEMA's Stds Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."

F. IEEE Compliance: Comply with applicable portions of IEEE Std 1262, "Recommended Practices for Qualifications of Photovoltaic Modules."

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver photovoltaic equipment and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for photovoltaic modules and components which protect equipment from damage.

B. Store photovoltaic equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle photovoltaic equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Modules :

1. PV modules must be listed on the NYSERDA PTC list and must qualify for eligibility under the NYSERDA/NABCEP RE Program.
2. System must comply with IEEE 1262 “Recommended Practice for Qualifications of Photovoltaic Modules”.

B. Electric Power Requirements:

1. Power provided must be compatible with the onsite distribution system.
2. The System must include all hardware needed for the solar PV.
3. All systems must be installed in accordance with all applicable requirements of local electrical codes and the National Electrical Code (NEC), including but not limited to Article 690, “Solar Photovoltaic Systems” and Article 705 – “Interconnected Electrical Power Production Sources”.
4. Systems must be designed and installed using UL or ETL listed components, including mounting systems.
5. Modules must be certified to UL 1703 – “Flat-Plate Photovoltaic Modules and Panels”.
6. Inverters must comply with the following requirements
    a. IEEE 929-2000 –“Recommended Practice for Utility Interface of Photovoltaic Systems”.
    b. UL 1741 – “Standard for Static Inverters and Charge Controllers for use in Photovoltaic Systems”.
    c. Listed on the CEC list of eligible converters.
7. Other technical codes that will apply include:
    a. AMSE PTC 50 (solar PV performance)
    b. ANSI Z21.83 (solar PV performance and safety)
    c. NFPA 853 (solar PVs near buildings)
    d. NEPA 70 (electrical components)
    e. National Electrical Safety Code – ANSI C2 – 1999
    f. All applicable State Building Codes and requirements
8. All Balance of Systems (wiring, component, wiring, conduits, and connections) must be suited for conditions for which they are to be installed. When possible, inverters shall be located inside out of the weather in a minimum NEMA 12 enclosure. If inverters are in exterior locations, they shall be installed in all-weather NEMA 4X enclosures. An interval data meter must be installed to measure the AC output of the inverter. This meter should be located in a location accessible to University facilities personnel.
9. Interconnection must comply with Central Hudson Power and Light, Interconnection Standards for non-Utility Generation”. Prepare and submit appropriate interconnection agreements with CHP+L.

C. Meters:

1. Contractor shall provide connection to the Building’s Energy Management System (EMS) for the purposes of metering, monitoring and data collection of solar production.

2. Meters must connect to a monitoring/data collection recording solar production through Time of Use (TOU) increments applicable to the local utility standards, with a minimum 15 minute intervals.

D. Structural Requirements:

1. All structures and structural elements, including array structures, shall be designed in accordance with all applicable NY State Building Codes and standards pertaining to the erection of such structures.
2. The licensee shall provide structural calculations, stamped by a licensed professional structural engineer in good standing with the State of New York.
3. All structural components, including array structures, shall be designed in a manner commensurate with attaining a minimum of 30 year design life. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.
4. The structural design should provide for easy and cost effective repair or replacement of the roof. Contractor shall expect to remove and replace roof mounted solar systems no more than one time during the contract period at no expense to building management, to allow for major roofing maintenance, including installing a new roof.
5. Any roof penetrations must be designed and constructed in collaboration with the roofing professional or manufacturer responsible for the roof and roofing material warranty for the specific site, to ensure that the existing roof warranty is not invalidated by the installation of the PV system.

E. System Service Contract:

1. The supplier of the PV system must provide a copy and make available to the owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract will accompany any documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc. submitted for approval to the designing engineer. The Contract shall be for the complete services rendered over a period of one year.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which diesel engine-driven generator units are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SOLAR PV SYSTEM SETS

A. Wherever the requirements of other articles of this Code and Article 690 differ, the requirements of Article 690 shall apply and, if the system is operated in parallel with a primary source(s) of electricity, the requirements in 705.14, 705.16, 705.32, and 705.43 shall apply

1. A solar photovoltaic system shall be permitted to supply a building or other structure in addition to any service(s) of another electricity.

B. Conductors of Different Systems: Photovoltaic source circuits and photovoltaic output circuits shall not be contained in the same raceway, cable tray, cable, outlet box, junction box, or similar fitting as feeders or branch circuits of other systems, unless the conductors of the different systems are separated by a partition or are connected together.

C. Module Connection Arrangement: The connections to a module or panel shall be arranged so that removal of a module or panel from a photovoltaic source circuit does not interrupt a grounded conductor to another photovoltaic source circuit. Sets of modules interconnected as systems rated at 50 volts or less, with or without blocking diodes and having a single overcurrent device shall be considered as a single-source circuit. Supplementary overcurrent devices used for the exclusive protection of the photovoltaic modules are not considered as overcurrent devices for the purpose of this section.

D. Equipment: Inverters or motor generator shall be identified for use in solar photovoltaic systems. Equipment listed for marine, mobile, telecommunications, or other applications may not be suitable for installation in permanent PV power systems complying with the Code.

3.3 GROUND FAULT PROTECTION

A. Roof –mounted dc photovoltaic arrays located on dwellings shall be provided with dc ground-fault protection to reduce fire hazards.

B. Ground-Fault Detection and Interruption: The ground-fault protection device or system shall be capable of detecting a ground fault, interrupting the flow of fault current, and providing an indication of the fault.

Typical ground-fault protection devices meeting the requirements of 690.5(A) operate by opening the main dc bonding jumper. They sense dc ground faults anywhere on the dc system and may be mounted anywhere in that system. They are installed inside the utility-interactive inverters.

C. Disconnection of Conductors: The ungrounded conductors of the faulted source circuit shall be automatically disconnected. If the grounded conductors of the faulted source circuit are disconnected to comply with the requirements of 690.5(A), all conductors of the faulted source circuit shall be opened automatically and simultaneously. Opening the grounded conductor of the array or opening the faulted sections of the array shall be permitted to interrupt the ground-fault current path.

D. Labels and Markings: Labels and marking shall be applied near the ground-fault indicator at a visible location, stating that, if a fault is indicated, the normally grounded conductors may be energized and ungrounded.

3.4 ALTERNATING-CURRENT (AC) MODULES

A. Photovoltaic Source Circuits: The requirements of Article 690 pertaining to photovoltaic source circuits shall not apply to ac modules. The photovoltaic source circuit, conductors and inverters shall be considered as internal wiring of an ac module.

B. Inverter Output Circuit: The output of an ac module shall be considered an inverter output circuit.

C. Disconnecting Means: A single disconnecting means, in accordance with 690.15 and 690.17, shall be permitted for the combined ac output of one or more ac modules. Additionally, each ac module in a multiple ac-module system shall be provided with a connector, bolted, or terminal-type disconnecting means.

D. Ground-Fault Detection: Alternating-current-module systems shall be permitted to use a single detection device to detect only ac ground faults and to disable the array by removing ac power to the ac module(s).

E. Overcurrent Protection: The output circuits of ac modules shall be permitted to have overcurrent protection and conductor sizing in accordance with 240.5(B)(2).

3.5 CIRCUIT REQUIREMENTS

A. Maximum Photovoltaic System Voltage: In a dc photovoltaic source circuit or output circuit, the maximum photovoltaic system voltage for that circuit shall be calculated as the sum of the rated open-circuit voltage of the series-connected photovoltaic modules corrected for the lowest expected ambient temperature. For crystalline and multicrystalline silicon modules, the rated open-circuit voltage shall be multiplied by the correction factor provide in Table 690.7. This voltage shall be used to determine the voltage rating of cables, disconnects, overcurrent devices, and other equipment. Where the lowest expected ambient temperature is below -40˚C (-40˚F), or where other than crystalline or multicrystalline silicon photovoltaic modules are used, the system voltage adjustment shall be made in accordance with the manufacturer's instructions.

B. Direct-Current Utilization Circuits: The voltage of dc utilization circuits shall conform with 210.6.

C. Photovoltaic Source and Output Circuits: In one- and two-family dwellings, photovoltaic source circuits and photovoltaic output circuits that do not include lampholders, fixtures, or receptacles shall be permitted tohave a maximum photovoltaic system voltage up to 600 volts. Other installations with a maximum photovoltaic system voltage over 600 volts shall comply with Article 690, Part I.

D. Circuits Over 150 Volts to Ground: In one- and two-family dwellings, live parts in photovoltaic source circuits and photovoltaic output circuits over 150 volts to ground shall not be accessible to other than qualified persons while energized.

E. Calculation of Maximum Circuit Current: The maximum current for the specific circuit shall be calculated in accordance with 690.8(A)(1) through (A)(4).

F. Photovoltaic Source Circuit Currents: The maximum current shall be the sum of parallel module rated short-circuit currents multiplied by 125 percent.

G. Photovoltaic Output Circuit Currents: The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1).

H. Inverter Output Circuit Current: The maximum current shall be the inverter continuous output current rating.

Utility-interactive inverters are power-limited devices. Output circuits connected to these devices are sized on the continuous rated outputs of these devices and are not based on load calculations or reduced-size PV arrays, if any. Some inverters may have specifications listing sustained maximum output currents and the higher of this number or the rated output should be used.

I. Ampacity and Overcurrent Device Ratings: Photovoltaic system currents shall be considered to be continuous.

J. Sizing of Conductors and Overcurrent Devices: The circuit conductors and overcurrent devices shall be sized to carry not less than 125 percent of the maximum currents as calculated in 690.8(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

K. Internal Current Limitation: Over current protection for photovoltaic output circuits with devices that internally limit the current from the photovoltaic output circuit shall be permitted to be rated at less than the value calculated in 690.8(B)(1). This reduced rating shall be at least 125 percent of the limited current value. Photovoltaic output circuit conductors shall be sized in accordance with 690.8(B)(1).

L. System with Multiple Direct-Current Voltages: For a photovoltaic power source that has multiple output circuit voltages and employs a common-return conductor, the ampacity of the common-return conductor shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.

M. Sizing of Module Interconnection Conductors: Where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall not be less than the sum of the rating of the single fuse plus 125 percent of the short-circuit current from the other parallel-connected modules.

3.6 OVERCURRENT PROTECTION

A. Circuits and Equipment: Photovoltaic source circuit, photovoltaic output circuit, inverter output circuit, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 240. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

B. Power Transformers: Overcurrent protection for a transformer with a source(s) on each side shall be provided in accordance with 450.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.

C. Photovoltaic Source Circuits: Branch-circuit or supplementary-type overcurrent devices shall be permitted to provide overcurrent protection in photovoltaic source circuits. The overcurrent devices shall be accessible but shall not be required to be readily accessible.

Standard values of supplementary overcurrent devices allowed by this section shall be in one ampere size increments, starting at one ampere up to and including 15 amperes. Higher standard values above 15 amperes for supplementary overcurrent devices shall be based on the standard sizes provided in 240.6(A).

If the overcurrent protection of PV source circuits is considered supplementary overcurrent protection, use of overcurrent devices with ratings other than those suitable for branch-circuit protection is permitted. The use of such devices permits module protection closer to the specified ratings required on the labels attached to listed modules. It is anticipated that only qualified service personnel will replace or reset overcurrent devices in PV source circuits. Consequently, ready access to the user need not be provided. These supplementary overcurrent devices must be listed for dc operation and have appropriate voltage and current ratings.

D. Direct-Current Rating: Overcurrent devices, either fuses or circuit breakers, used in any dc portion of a photovoltaic power system shall be listed for use in dc circuits and shall have the appropriate voltage, current, and interrupt ratings.

E. Series Overcurrent Protection: In series-connected strings of two or more modules, a single overcurrent protection device shall be permitted.

The single overcurrent device (when required) may provide both the reverse-current protection required for the series-connected PV modules and the overcurrent protection required for the interconnecting conductors.

3.7 DISCONNECTING MEANS

A. All Conductors: Means shall be provided to disconnect all current-carrying conductors of a photovoltaic power source from all other conductors in a building or other structure. A switch or circuit breaker shall not be installed in a grounded conductor unless that switch or circuit breaker is part of a ground-fault detection system required by 690.5 and that switch or circuit breaker is automatically opened and indicated as a normal function of the device in responding to ground faults.

B. Additional Provisions: Photovoltaic disconnecting means shall comply with 690.14(A) through 690.14(D).

C. Disconnecting Means: The disconnecting means shall not be required to be suitable as service equipment and shall be rated in accordance with 690.17.

D. Equipment: Equipment such as photovoltaic source circuit isolating switches, overcurrent devices, and blocking diodes shall be permitted on the photovoltaic side of the photovoltaic disconnecting means.

E. Requirements for Disconnecting Means: Means shall be provided to disconnect all conductors in a building or other structure from the photovoltaic system conductors.

1. Location: The photovoltaic disconnecting means shall be installed at a readily accessible location either on the outside of a building or structure or inside nearest the point of entrance of the system conductors. The photovoltaic system disconnecting means shall not be installed in bathrooms.
2. Marking: Each photovoltaic system disconnecting means shall be permanently marked to identify it as a photovoltaic system disconnect.
3. Suitable for Use: Each photovoltaic system disconnecting means shall be suitable for the prevailing conditions. Equipment installed in hazardous (classified) locations shall comply with the requirements of Articles 500 through 517.
4. Maximum Number of Disconnects: The photovoltaic system disconnecting means shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard.

5. Grouping: The photovoltaic system disconnecting means shall be grouped with other disconnecting means for the system to comply with 690.14(C)(4). A photovoltaic disconnecting means shall not be required at the photovoltaic module or array location.

F. Utility-Interactive Inverters Mounted in Not-Readily-Accessible Locations: Utility-interactive inverters shall be permitted to be mounted on roofs or other exterior areas that are not readily accessible. These installations shall comply with (1) through (4):
1. A direct-current photovoltaic disconnecting means shall be mounted within sight of or in the inverter.
2. An alternating-current disconnecting means shall be mounted within sight of or in the inverter.

The requirements in 690.14(D)(1) and 690.14(D)(2) provide for servicing disconnects at the inverter.

3. The alternating-current output conductors from the inverter and an additional alternating-current disconnecting means for the inverter shall comply with 690.14(C)(1).

The requirements in 690.14(C)(1) allows the inverter and the circuit to it to be de-energized from a readily accessible location.

4. A plaque shall be installed in accordance with 705.10.

G. Disconnection of Photovoltaic Equipment

1. Means shall be provided to disconnect equipment, such as inverters, batteries, charge controllers, and the like, from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.
2. A single disconnecting means in accordance with 690.17 shall be permitted for the combined ac output of one or more inverters or ac modules in an interactive system.

H. Fuses

1. Disconnecting means shall be provided to disconnect at a fuse from all sources of supply if the fuse is energized from both directions and is accessible to other than qualified persons. Such a fuse in a photovoltaic source circuit shall be capable of being disconnected independently of fuses in other photovoltaic source circuits.
2. Switches, pullouts, or similar devices that have suitable ratings may serve as means to disconnect fuses from all sources of supply.

I. Switch or Circuit Breaker

1. The disconnecting means for ungrounded conductors shall consist of a manually operable switch(es) or circuit breaker(s) complying with all of the following requirements:
   a. Located where readily accessible.
   b. Externally operable without exposing the operator to contact with live parts.
   c. Plainly indicating whether in the open or closed position.
   d. Having an interrupting rating sufficient for the normal circuit voltage and the current that is available at the line terminals of the equipment.
2. Where all terminals of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and have the following words or equivalent:

WARNING
ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

J. Installation and Service of an Array

1. Open circuiting, short circuiting, or opaque covering shall be used to disable an array or portions of an array for installation and service:

FPN: Photovoltaic modules are energized while exposed to light. Installation, replacement, or servicing of array components while a module(s) is irradiated may expose persons to electric shock.

3.8 WIRING METHODS

A. Wiring Systems: All raceway and cable wiring methods included in Code and other wiring systems and fittings specifically intended and identified for use on photovoltaic arrays shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

B. Single-Conductor Cable: Types SE, UF, USE, and USE-2 single-conductor cable shall be permitted in photovoltaic source circuits where installed in the same manner as a Type UF multiconductor cable in accordance in accordance with Part II of Article 340. Where exposed to sunlight, Type UF cable identified as sunlight-resistant shall be used.

C. Small-Conductor Cables: Single-conductor cables listed for outdoor use that are sunlight resistant and moisture resistant in sizes 16 AWG and 18 AWG shall be permitted for module interconnections where such cables meet the ampacity requirements of 690.8. Section 310.15 shall be used to determine the cable ampacity and temperature derating factors.

D. Direct-Current Photovoltaic Source and Output Circuits Inside a Building: Where direct current photovoltaic source or output circuits of a utility-interactive inverter from a building-integrated or other photovoltaic system are run inside a building or structure, they shall be contained in metallic raceways or enclosures from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. The disconnecting means shall comply with 690.14(A) through 690.14(D).

E. Component Interconnections: Fittings and connectors that are intended to be concealed at the time of on-site assembly, where listed for such use, shall be permitted for on-site interconnection of modules or other array components. Such fittings and connectors shall be equal to the wiring method employed in insulation, temperature rise, and fault-current withstand, and shall be capable of resisting the effects of the environment in which they are used.

F. Connectors: The connectors permitted by Article 690 shall comply with 690.33(A) through 690.33(E).

1. Configuration: The connectors shall be polarized and shall have a configuration that is noninterchangeable with receptacles in other electrical systems on the premises.
2. Guarding: The connectors shall be constructed and installed so as to guard against inadvertent contact with live parts by persons.
3. Type: The connectors shall be of the latching or locking type.
4. Grounding Member: The grounding member shall be the first to make and the last to break contact with the mating connector.
5. Interruption of Circuit: The connectors shall be capable of interrupting the circuit current without hazard to the operator.

G. Access to Boxes: Junction, pull, and outlet boxes located behind modules or panels shall be so installed that the wiring contained in them can be rendered accessible directly or by displacement of a module(s) or panel(s) secured by removable fasteners and connected by a flexible wiring system.

3.9 GROUNDING

A. System Grounding: For a photovoltaic power source, one conductor of a two-wire system with a photovoltaic system voltage over 50 volts and the reference (center tap) conductor of a bipolar system shall be solidly grounded or shall

use other methods that accomplish equivalent system protection in accordance with 250.4(A) and that utilize equipment listed and identified for the use.

B. Point of System Grounding Connection: The dc circuit grounding connection shall be made at any single point on the photovoltaic output circuit.

If other than solid grounding is utilized, as permitted by 690.41, the connections should be made in accordance with the markings found on the equipment or in the installation instructions.

C. Equipment Grounding: Exposed non-current-carrying metal parts of module frames, equipment, and conductor enclosures shall be grounded in accordance with 250.134 or 250.136(A) regardless of voltage.

D. Size of Equipment Grounding Conductor: Where not protected by the ground-fault protection equipment required by 690.5, the equipment-grounding conductor for photovoltaic source and photovoltaic output circuits shall be sized for 125 percent of the photovoltaic-originated short-circuit currents in that circuit. Where protected by the ground-fault protection equipment required by 690.5, the equipment-grounding conductors for photovoltaic source and photovoltaic output circuits shall be sized in accordance with 250.122.

E. Grounding Electrode System

1. Alternating-Current Systems: If installing an ac system, a grounding electrode system shall be provided in accordance with 250.50 through 250.60. The grounding electrode conductor shall be installed in accordance with 250.64.
2. Direct-Current Systems: If installing a dc system, a grounding electrode system shall be provided in accordance with 250.177 for grounded systems or 250.169 for un-grounded systems. The grounding electrode conductor shall be installed in accordance with 250.64.
3. Systems with Alternating-Current and Direct-Current Grounding Requirements: Photovoltaic power systems with both alternating-current and direct-current (dc) grounding requirements shall be permitted to be grounded as described in (1) or (2).
4. A grounding-electrode conductor shall be connected between the identified dc grounding point to a separate dc grounding electrode. The dc grounding-electrode conductor shall be sized according to 250.166. The dc grounding electrode shall be bonded to the ac grounding electrode to make a grounding electrode system according to 250.52 and 250.53. The bonding conductor shall be no smaller than the largest grounding electrode conductor, either ac or dc.
5. The dc grounding electrode conductor and ac grounding electrode conductor shall be connected to a single grounding electrode. The separate grounding electrode conductors shall be sized as required by 250.66 (ac) and 250.166 (dc).

F. Continuity of Equipment Grounding Systems: Where the removal of equipment disconnects the bonding connection between the grounding electrode conductor and exposed conducting surfaces in the photovoltaic source or output circuit equipment, a bonding jumper shall be installed while the equipment is removed.

G. Continuity of Photovoltaic Source and Output Circuit Grounded Conductors: Where the removal of the utility-interactive inverter or other equipment disconnects the bonding connection between the grounding electrode conductor and the photovoltaic source and/or photovoltaic output circuit grounded conductor, a bonding jumper shall be installed to maintain the system grounding while the inverter or other equipment is removed.

PART 4 – MISCELLANEOUS

4.1 MARKING

A. Modules: Modules shall be marked with identification of terminals or leads as to polarity, maximum overcurrent device rating for module protection, and with the following ratings:

1. Open-circuit voltage
2. Operating voltage
3. Maximum permissible system voltage

4. Operating current
5. Short-circuit current
6. Maximum power

B. Alternating-Current Photovoltaic Modules: Alternating-current modules shall be marked with identification of terminals or leads and with identification of the following ratings:
1. Nominal operating ac voltage
2. Nominal operating ac frequency
3. Maximum ac power
4. Maximum ac current
5. Maximum overcurrent device rating for ac module protection

C. Direct-Current Photovoltaic Power Source: A marking for the direct-current photovoltaic power source indicating terms (1) through (4) shall be provided by the installer at an accessible location at the disconnecting means for this power source:
1. Operating current
2. Operating voltage
3. Maximum system voltage
4. Short-circuiting current

D. Interactive System Point of Interconnection: All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source with the maximum ac output operating current and operating ac voltage.

4.2 CONNECTION TO OTHER SOURCES

A. Identified Interactive Equipment: Only inverters and ac modules listed and identified as interactive shall be permitted in interactive systems.

B. Loss of Interactive System Power: An inverter or an ac module in an interactive solar photovoltaic system shall automatically de-energize its output to the connected electrical production and distribution network upon loss of voltage in that system and shall remain in that state until the electrical production and distribution network voltage has been restored.

C. Ampacity of Neutral Conductor: If a single-phase, 2-wire inverter output is connected to the neutral and one ungrounded conductor (only) of a 3-wire system or of a 3-phase, 4-wire wye-connected system, the maximum load connected between the neutral and any one ungrounded conductor plus the inverter output rating shall not exceed the ampacity of the neutral conductor.

D. Unbalanced Interconnections:

1. Single Phase: Single-phase inverters for photovoltaic systems and ac modules in interactive solar photovoltaic systems shall not be connected to 3-phase power systems unless the interconnected system is designed so that significant unbalanced voltages cannot result.
2. Three Phase: Three-phase inverters and 3-phase ac modules in interactive systems shall have all phases automatically de-energized upon loss of, or unbalanced, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

E. Point of Connection: The output of a photovoltaic power source shall be connected as specified in 690.64(A) or 690.64(B).

1. Supply Side: A photovoltaic power source shall be permitted to be connected to the supply side of the service disconnecting means as permitted in 230.82(6).
2. Load Side: A photovoltaic power source shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises, provided that all of the following conditions are met:

a. Each source interconnection shall be made at a dedicated circuit breaker or fusible disconnecting means.
b. The sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed the rating of the busbar or conductor.
c. The interconnection point shall be on the line side of all ground-fault protection equipment.
d. Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor shall be marked to indicate the presence of all sources.
e. Circuit breakers, if backed, shall be identified for such operation. Dedicated circuit breakers backfed from listed utility-interactive inverters complying with 690.60 shall not be required to be individually clamped to the panelboard busbars. A front panel shall clamp all circuit breakers to the panelboard busbars. Main circuit breakers connected directly to energized feeders shall also be individually clamped.

4.3 SYSTEMS OVER 600 VOLTS

A. General: Solar photovoltaic systems with a maximum system voltage over 600 volts dc shall comply with Article 490 and other requirements applicable to installations rated over 600 volts.

B. Photovoltaic Circuits: In dc photovoltaic source circuits and photovoltaic output circuits, the maximum system voltage.

4.4 POINT OF CONNECTION

The outputs of electric power production systems shall be interconnected at the premises service disconnecting means.

A. Integrated Electric System: The outputs shall be permitted to be interconnected at a point or points elsewhere on the premises where the system qualifies as an integrated electric system and incorporates protective equipment in accordance with all applicable sections of Article 685.

B. General: The outputs shall be permitted to be interconnected at a point or points elsewhere on the premises where all of the following conditions are met:

1. The aggregate of non-utility sources of electricity has a capacity in excess of 100 kW, or the service is above 1000 volts.
2. The conditions of maintenance and supervision ensure that qualified persons service and operate the system.
3. Safeguards and protective equipment are established and maintained.

C. Output Characteristics: The output of a generator or other electric power production source operating in parallel with an electric supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected.

D. Interrupting and Short-Circuit Current Rating: Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

E. Disconnecting Mean, Sources: Means shall be provided to disconnect all ungrounded conductors of an electric power production source(s) from all other conductors.

F. Disconnecting Means, Sources: Means shall be provided to disconnect equipment, such as inverters or transformers associated with a power production source, from all ungrounded conductor of all sources of supply. Equipment intended to be operated and maintained as an integral part of a power production source exceeding 1000 volts shall not be required to have a disconnecting means.

G. Disconnect Device: The disconnecting means for ungrounded conductors shall consist of manually or power operable switch(es) or circuit breaker(s) with the following features:

1. Located where accessible.
2. Externally operable without exposing the operator to contact with live parts and, if power operable, of a type that can be opened by hand in the event of a power supply failure.

3. Plainly indicating whether in the open or closed position.
4. Having ratings not less than the load to be carried and the fault current to be interrupted.

For disconnect equipment energized from both sides, a marking shall be provided to indicated that all contacts of the disconnect equipment may be energized.

4.5 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating PV System sets. In addition, train Owner's personnel in periodic maintenance of equipment and components.

END OF SECTION

SECTION 26 32 13

DIESEL GENERATOR SETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provision of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of diesel generator set work is indicated by drawings and is hereby defined to include, but not by way of limitation, diesel engine, electrical generator, engine starting system including batteries, instrument control panel, transfer switches, fuel tanks, annunciator panel, exhaust silencer, vibration isolation, wall thimble, accessories, load bank, and generator enclosure.

B. The generator and transfer switches shall be furnished by the same manufacturer.

C. Refer to Division-3 sections for concrete and grout work required in connection with pads for engine-driven generator set; work of this section.

D. Refer to Division-23 sections for fuel tank piping and associated accessories required for installation of diesel engine-generator unit.

E. All unit (skid) mounted fuel tank piping and accessories required are work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on diesel engine-driven generator sets and components. Include manufacturer's standard product warranty, for duration of not less than two-years, for replacement of materials and equipment used in diesel generator systems.

B. Shop Drawings: The Contractor shall submit a copy of this specification section with the words "comply" or "not comply" marked in the margins of each paragraph shall be submitted along with copies of pertinent drawings and schematic diagrams for approval which shall include the following:

1. Engine generator set including plans and elevations or riser views clearly indicating entrance points for each of the interconnections required.
2. Slip-over steel housing showing all pertinent dimensions and details. Exhaust silencer(s) will be supported above roof of the enclosure.
3. Engine generator/exciter control cubicle.
4. Fuel consumption rate curves at various loads, ventilation and combustion CFM requirements.
5. Exhaust muffler, critical silencer, and vibration isolators.
6. Battery charger, battery, and battery rack.
7. Fuel tank connection points.
8. Automatic load transfer switch.
9. Legends for all devices on all diagrams.
10. Load bank.

11. A complete ½" = 1'-0" scale drawing showing the exact generator and transfer switch system layout including all components and accessories being provided or required for operation as specified herein.
12. Main circuit breaker.
13. Spring isolators and Korfund parts.

C. Wiring Diagrams: Submit wiring diagrams for diesel engine-driven generator unit showing connections to electrical power panels, feeders, automatic transfer switches, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field-installed.

D. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit 4 copies of an agreement for continued service and maintenance of diesel engine-driven generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner. Refer to paragraph 26 32 13-2.10(M).

E. Certifications: Provide diesel engine-drive generator sets certified test record of the following final production testing:

1. Single-step load pickup.
2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated power.
6. Maximum power.

F. Provide certified test record prior to engine-driven generator set being shipped from factory to project location.

1.4 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of diesel engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with diesel engine-driven generator units similar to that required for this project.

1. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of diesel engine-driven generator units.

C. Generator Supplier Qualifications: Generator supplier shall be factory-authorized distributor nearest to the project location for the system being provided. There shall be a distributor for the generator manufacturer within a driving distance of 50 miles. Generator supplier shall certify that they employ at least two technicians who have attended all factory service schools. Supplier shall certify that they offer 24-hour, 7-day field service and maintain the manufacturer's recommended parts inventory on all field service vehicles, as well as a complete recommended service parts stock at their location nearest the project.

D. Codes and Standards:

1. Electrical Codes Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 700, 701, and 702 pertaining to construction and installation of emergency and standby systems.
2. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures".

3. UL Compliance: Comply with applicable requirements of UL 1008, “Automatic Transfer Switches,” UL 486A, “Wire Connectors and Soldering Lugs for Use with Copper Conductors,” and UL 486B, “Wire Connectors for Use with Aluminum Conductors.”
4. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1 “Motors and Generators,” and MG 2, “Safety and Use of Electric Motors and Generators”.

E. NEMA Compliance: Comply with applicable requirements of NEMA’s Stds Pub No. 250, “Enclosures for Electrical Equipment (1000-Volts Maximum).”

F. IEEE Compliance: Comply with applicable portions of IEEE Std 446, “IEEE Recommended Practices for Emergency and Standby Power Systems for Industrial and Commercial Applications.”

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver diesel engine-driven generator properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.

B. Store diesel engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle diesel engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Performance:

1. Standby kw: 600kW
2. Power factor: 0.8
3. Speed: 1,800 RPM
4. Generator output voltage: 480/277V
5. Units shall be certified by the manufacturer to provide the rated kw at altitude and 120 ambient temperature.
6. It is intended that all products specified herein be of standard ratings, therefore the kw and kVA ratings, ampere ratings, withstand and closing ratings, etc., shall be the manufacturer’s next larger size or rating when the specifications cannot be exactly met.
7. In a standby power capacity, the unit shall be capable of continuous service at rated output for the duration of any utility power failure. The engine and generator shall be the product of a single manufacturer; and that manufacturer and its authorized dealer shall have the responsibility to provide the diesel engine/generator set and its accessories which will meet the specified output at the required altitude and ambient temperature. It shall be a new factory assembled and tested set. It is the intent and purpose of these specifications to also secure for the Owner, the necessary controls and accessories to the extent that this equipment, in conjunction with the diesel/engine/generator set, will comprise a complete operating package unit.
8. Rating of the diesel engine/generator set shall be based on operation of the set when equipped with all necessary operating accessories, such as radiator fan, air cleaners, lubrication oil pump, fuel transfer pump, fuel injection pump, jacket water pump, governor, charging generator, alternating current generator, and exciter regulator. These ratings must be substantiated by manufacturer’s standard published curves and test data. Special ratings or maximum ratings are not acceptable.
9. Voltage regulation shall be +/-2.0 percent of rate voltage for any constant load between no load and rated load.

10. Frequency regulation shall be 5 percent from steady state no load to steady state rated load.
11. Total Harmonic distortion: The sum of AC voltage waveform harmonics, from non load to full linear load, shall not exceed 5% of rated voltage (L-N, L-L, L-L-L) and no single harmonic shall exceed 3% of rated voltage.
12. Telephone Influence Factor: TIF shall be less than 50 per NEMA MG1-22.43.
13. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kw and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
14. Motor starting capability shall after an initial instantaneous voltage dip not to exceed 15 percent, be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA at near zero power factor applied to the generator set.

B. Engine:

1. The engine shall be watercooled inline or Vee-type two or four stroke cycle compression ignition diesel. It shall meet specifications when operating on Number 2 domestic burner oil. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump fuel priming pump, service meter, gear driven water pump, and unit mounted instruments, including a fuel pressure gauge, water temperature gauge, and lubrication oil pressure gauge. All crankcase emissions will be directed through a demister unit, CRANK VENT from Diesel Research, Inc. or equivalent.
2. Governor - The engine governor shall maintain frequency regulation not to exceed +/-0.25% from no load to full rated load. Units shall be furnished with an electronic isochronous governor. Governor shall incorporate rack position limiter for start-up, field adjustable to minimize smoke during start-up and acceleration.
3. Mounting - The unit shall be mounted on a structural steel sub-base and shall be provided with suitable spring-type vibration isolators and korfund pads. Sub-base shall be sized to accommodate an under skid mounted double walled fuel tank (8 hours minimum size).
4. Safety Devices - Safety shut-offs for high water temperature, low oil pressure, low coolant level, low coolant temperature, low fuel, overspeed, and engine overcrank shall be provided.
5. Engine-mounted battery charging alternator, 45 ampere, and solid-state voltage regulator.
6. Accessories: Provide replaceable type oil filters, dry-type air cleaners, lubricating oils, greases, and coolant.
7. Install engine at sufficient height above base to permit dropping oil pan without removing unit.
8. All rotating parts shall be guarded against accidental contact.

C. Generator:

1. The generator shall be rated for continuous standby service at 0.8 power factor, 60 hertz, 1800 RPM. The unit shall be capable of 100% block load per NFPA 110.
2. NFPA 110 required full load test at rated power factor shall be done in factory.
3. The A.C. generator shall be; synchronous, four-pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s). The starter shall have skewed laminations of insulated electrical grade seal, two thirds pitch windings. The rotor shall have amortissuer (damper) windings. The rotor shall be dynamically balanced. The exciter shall be brushless, three-phase, with full wave silicon diodes mounted on the rotating shaft and a surge suppressor connected in parallel with the field winding.
4. All insulation system components shall meet NEMA (MGI0221.40 and 16.40) standard temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105ºC.
5. The generator shall be broad range, 12 lead reconnectable. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage within the broad range.
6. The main generator and exciter insulation systems must be suitably impregnated for operation in severe environments for resistance to sand, salt, and sea spray.
7. A shunt excitation system shall derive excitation power from the main generator output. The automatic voltage regulator shall be temperature compensated, half wave phase controlled solid-state design and include an underspeed protection function. The regulator design shall include a torque-matching characteristic to allow the engine to use its fullest power producing capability (without exceeding it or

overcompensating) as speed lower than rated, to optimize motor starting capability and to provide the fastest possible recovery from the transient speed dips.

8. Regulator - A generator-mounted, volts-per-hertz-type exciter/regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be plus or minus 0.5% from no load to full rated load. Readily accessible voltage drop, voltage level, and voltage gain controls shall be provided. Voltage level adjustment shall be a minimum of plus or minus 5%. The solid-state regulator module shall be shock-mounted and epoxy-encapsulated for protection against vibration and atmospheric deterioration. Provide terminal box for generator and exciter leads. The regulator must be sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.

D. Cooling System:

1. Radiator - A radiator with blower type fan shall be sized to maintain safe operation at 130º F ambient temperature. The fan shall be capable of accommodating air flow restrictions external to the radiator/generator package of at least 0.5" H_20 ESP at 54,000 CFM. If a greater air is required, the fan shall accommodate an ESP={(required CFM)/54,000 CFM}^{2*}0.5.
2. The engine cooling system shall be pre-treated by the engine supplier for the inhibition of internal corrosion.

E. Fuel System:

1. Skid and double walled tank shall be built below the structural base of the generator set and shall have a 1200 gallon capacity. No fuel piping shall be required. Engine shall be complete and ready to run when delivered to the site. Contractor shall provide all fuel required for site set-up and testing. After installation has been accepted, Contractor shall "top-off": base tank with No. 2 fuel oil.
2. An engine driven, mechanical, positive displacement fuel pump; fuel/water separator; fuel filter with replaceable spin-on canister element; fuel pressure gauge and fuel priming pump; flexible supply and return fuel lines.

F. Exhaust System:

1. Exhaust Silencer - A critical type silencer, muffler companion flanges, and two minimum 3'-0" long flexible stainless steel exhaust connectors properly sized shall be furnished and installed according to the manufacturer's recommendation. Mounting shall be provided by the Contractor. The silencer shall be mounted so that its weight is not supported by the engine, nor will the exhaust system growth, due to thermal expansion, be imposed on the engine. The exhaust back pressure capability of the engine shall accommodate a minimum of 35" ESP including muffler and flex connectors. Maximum pressure drop of the muffler and flex connectors at full load shall be 10" w.c.
2. Insulation - The muffler and all indoor exhaust piping shall be lagged by the Contractor to maintain a surface temperature not to exceed 150º F. The insulation shall be installed so that it does not cover or interfere with the functioning of the flexible exhaust fitting.
3. Contractor shall install exhaust pipe and insulation required.

G. Automatic Starting System:

1. Starting Motor - A 24 volt DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic Control - Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide shutdowns for low oil pressure, high water temperature, overspeed, overcrank and one auxiliary contact for activating accessory items. Controls shall include 3 complete cranking attempts without overheating before cranking cycle is lockout.
3. Jacket Water Heater - A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 90º F. The heater shall be 277 volts, single phase, 60 hertz. Vee-type engines of 12 cylinders or more shall have one heater per each bank of cylinders.

4. Batteries - A lead acid battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The cold cranking amps as recommended by the engine manufacture necessary cables and clamps shall be provided.
5. Battery Trays - Battery trays shall be provided for each battery and shall conform to NEC 480.8(b). They shall be constructed of wood and so treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil over battery electrolyte shall be contained within the tray to prevent a direct path to the ground.
6. Battery Charger - A current limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be not less than 5 amperes. Alarm contacts shall be provided for low voltage and battery charger failure. Charger shall be adjacent to generator. Status for generator shall be tied into building automation system. Provide wiring as required with conduit.
7. Provide remote on/off/status controls. Provide control wire and conduit back to generator. Assure controls are located 500 feet from generator.

H. Weatherproof Generator Enclosure

1. Reinforced steel housing allowing access to engine, generator, radiator, day tank and all other ancillary components. Housing shall have clearance width adequate to service the engine while it is running, but not less than 48 inches on both sides. Length will be adequate to accommodate the radiator, engine, generator, day tank, battery charger. Inside height will not be less than two feet above top of radiator filling cap.
2. Roof of enclosure shall be reinforced to accommodate mounting of engine silencer(s). Both sides will have louvers sized for cooling and combustion air intake, and be power activated to open with starting of engine. Both sides of housing will have full height, double hinged access doors. Doors will have not less than four latching points, operable from the inside and outside, and equipped with keyed alike locks. All enclosure wall shall have sound attenuation to reduce Db level.

I. Main Line Circuit Breaker:

1. Type - A main line, molded case circuit breaker mounted upon and sized to the output of the generator shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions. Manufacturer of breaker shall be the same as electrical equipment on this project.
2. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection provide with adjustments for long-term, short-term and instantaneous tripping. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electrical Manufacturers Association, and National Electrical Code.
3. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
4. Circuit breaker shall have battery voltage operated shunt trip wired to safety shutdowns to open the breaker in the event of engine failure.

J. Generator Control Panel:

1. Generator mounted NEMA 1 enclosed solid state module for engine control and AC metering. Panel shall contain, but not be limited to the following equipment:
   a. Auto/Manual start-stop with LED indicators for low oil pressure, high coolant temperature, prealarm low coolant pressure, pre-alarm high coolant temperature, low fuel, battery charger fault, low battery volts, low coolant temperature, not on auto, low coolant level, AC output fail over speed, over cranks and emergency stop. Safety shut-downs shall be automatic.
   b. Cyclic-cranking as specified by NFPA 110. (1-60 seconds crank/rest).
   c. Adjustable cool down timer (0-30 minutes).

d. LCD readout for: engine oil pressure, coolant temperature, engine RPM, system DC volts, engine running hours, generator AC volts, generator AC amps and generator frequency.
e. Engine control switch.
f. Ammeter - Voltmeter phase selector switch.
g. Emergency stop pushbotton.
h. Indicator/display test switch.
i. Voltage adjustment potentiometer.
j. Auxiliary relay, 3PDT.
k. Padlocking provisions.

2. Generator control panel shall be unit mounted and installed not more than 7'0" above the finished floor adjacent to the engine/generator set. Where control panel may be above the specified 7'0", the Electrical Subcontractor shall provide a working platform adjacent to the engine/generator set which will allow proper access to maintenance personnel (control panel within 7'0" of platform).

K. NFPA Requirements:

1. Annunciator Panel - Two panels shall be provided for remote mounting to give audible and visual warning of fault or alarm conditions in the generator set. The panel(s) shall conform with requirements of the National Electrical Code, and the National Fire Protection Association publication NFPA-110A. The panels shall be located in the building operation office and Fire Command Center..

L. Schedules:

1. In order to forecast and minimize engine failure, the supplier of the equipment must provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling.
2. Scheduled oil sampling shall be accurate within a fraction of one part per million for the following elements:
   a. Iron
   b. Chromium
   c. Copper
   d. Aluminum
   e. Silicon
   f. Lead
3. The sample shall be tested for the presence of water, fuel dilution, and anti-freeze.
4. All equipment needed to take oil samples shall be provided in a kit at the time of acceptance and shall include the following:
   a. Sample extraction gun (1)
   b. Bottles (10)
   c. Postage paid mailers (10)
   d. Written instruction (1)

M. System Service Contract:

1. The supplier of the standby power system must provide a copy and make available to the owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract will accompany any documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc. submitted for approval to the designing engineer. The Contract shall be for the complete services rendered over a period of one year.

N. Load Bank (Outdoor)

1. Description: Automatically-controlled multiple stage resistor integrally forced-air cooled load bank in a stationary free-standing NEMA 3R weatherproof enclosure. Load bank is to be used for periodic exercising of the emergency generator(s) under load. The unit shall include provisions for manual control from a remote location.

2. Characteristics: Unit shall be made up of not less than (4) continuously rated 480 volt 3-phase resistance stages designed and connected so as to provide a load of up to 200 KW.

   Steps shall be applied and removed as follows:
   a. Manually from the integral control panel.
   b. Manually from a remotely located panel, furnished with the load bank and installed complete with circuitry at a location as directed in the field.
   c. Automatically to maintain – in conjunction with building lighting and equipment connected to the generator – a nearly constant load.

3. Construction: The load bank shall be completely self-contained, incorporating all of the following, integrally mounted in a single enclosure except as otherwise noted:
   a. Load steps: Independent resistance stages, made up of chrome alloy wire, connected so as to provide load steps up to the total rating of the load bank. No stage shall exceed 50 KW.
   b. Each resistance stage shall be independently protected by means of factory installed current limiting fuses and shall be provided with a magnetic contactor. Fuses and magnetic contactor shall be factory wired so as to provide a self-protected, individually controllable unit for each stage.
   c. Main terminals arranged to accommodate a single power connection, sized for the full load rating of the load bank, complete with power circuit extensions to the protective devices for each branch circuit (i.e., stage).
   d. Main disconnect switch. If switch cannot be integrally mounted, provide with separate NEMA 3R enclosure mounted adjacent to load bank.
   e. Fused control transformer with 120 volt output.
   f. Integral control system incorporating the following features and functions:
      1) Local or remote manual application in stages of the load bank resistors, from a factory installed integrally mounted local control panel and/or a remotely located controlled panel furnished by the load bank supplier, and installed (complete with circuitry) as part of the work of this section at a location as directed in field.
      2) Automatic control of the load bank so as to disconnect the load bank (and initiate the cool-down sequence) on disturbances of normal power as sensed by a control circuitry extension to each automatic transfer switch.
      3) Automatic control of the load bank so as to maintain a nearby constant manually adjustable generator output throughout fluctuations in the “base loads” applied to the generator during either outages or scheduled “exercising under load”. Include circuitry connections to the generator panel.
      4) Generator voltages sensing to delay the applications of load until generator voltage and frequency have stabilized.
      5) Automatic protection against regenerative power from elevators. Include reverse power and overfrequency sensing and control logic.
      6) Selection at the local control panel of “Local-Manual,” “Local-Automatic” or “Remote” operation.
      7) Selection at the remote control panel of the “Remote-Manual,” “Remote-Automatic” or “Off.”
      8) Both control panels shall include step-by-step manual control as well as status lights.
   g. Integral forced air cooling system including TEFC motor driven direct connected fan, combination motor starter and temperature sensor.
   h. Malfunction detection system incorporating sensors, alarms and wiring for intake and exhaust air overtemperature and loss of cooling airflow; so arranged as to shut down load bank to avoid overheating.
   i. Complete set of factory installed power and control wiring. Cooling fan and control power shall be derived from a protected tap on the load side of the nearest transfer switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which diesel engine-driven generator units are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIESEL ENGINE-DRIVEN GENERATOR SETS

A. Install diesel engine-driven generator units in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.

B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel tanks, piping and accessories, as necessary to interface installation of engine-generator equipment work with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening valves for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A, 486B, and the National Electrical Code.

D. Install units on vibration isolators in accordance with Division-23 section; and comply with manufacturer's indicated method of installation.

E. Connect fuel oil piping to alternative generator equipment as indicated, and comply with manufacturer's installation instructions.

F. Align shafts of engine and generator within tolerances recommended by engine-generator unit manufacturer.

G. Generator set shall be capable of start-up and accepting rated load within ten (10) seconds.

H. Provide appropriate conduit and wiring from building normal panelboard, of appropriate voltage, to feed miscellaneous equipment such as jacket heaters, battery charger, etc. Coordinate power supplies with engine manufacturer. Provide separate conduits and wiring for each miscellaneous equipment.

3.3 GROUNDING

A. Provide equipment grounding connections for diesel engine-driven generator units. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

A. Start-up Testing:

1. Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with the Architect/Engineer in attendance; provide certified test record. Tests are to include the following:
    a. Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.

b. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: engine heaters, battery charger, generator strip heater, remote annunciator.
c. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to line voltage and phase rotation.
d. Test, by means of simulated power outage, automatic start-up, remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency

2. Perform an eight-hour load bank test with the following sequence:
   a. Two hours start-up 50% load.
   b. Four hours 100% load.
   c. Two hour 50% load.
   (Test results shall be documented and given to the engineer for review and approval.)
3. Upon completion of installation demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner.
4. Verify remote start/stop controls are operational.

3.5 PERSONNEL TRAINING

A. Building Operating Personnel Training: Provide 4 hours to train Owner's building personnel in procedures for starting-up, testing and operating diesel engine-driven generator sets. In addition, train Owner's personnel in periodic maintenance of batteries.

END OF SECTION

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provision of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of transfer switch work, including associated control devices, is indicated by drawings and schedules and as specified herein.

B. The generator and transfer switches shall be furnished by the same manufacturer.

C. Types of transfer switches required for the project include the following:

1. Automatic transfer.

D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, which are required in conjunction with transfer switch work; not work of this section.

E. Refer to Division-3 sections for concrete and grout work required in connection with transfer switch work; not work of this section.

F. Refer to Division-23 section for vibration control and isolation required in connection with transfer switches; not work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for electrical power transfer switches.

B. Shop Drawings: Submit ½"=1'-0" scale layout drawings of electrical generator and transfer switches showing accurately scaled equipment locations, housekeeping pad size, location and spatial relationships to associated electrical equipment in proximity.

C. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control devices showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of electrical power transfer switches, of types, rating, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Provide automatic transfer switches produced by a manufacturer listed as an Approved Manufacturer in this section.

C. Provide automatic transfer switch whose performance under specified conditions is certified by the manufacturer.

D. Service: The manufacturer must have a factory warehouse, at which spare parts are stocked and where a field service engineer permanently resides, located within 50 miles of the job site. The field service engineer shall be a full-time employee of the manufacturer, factory trained and qualified individual whose primary duty is field service.

E. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all the requirements of this Specification. The certifications shall identify, by serial number(s), the equipment involved.

F. Each transfer switch shall be furnished with an operator's manual providing installation and operating instructions.

G. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.

H. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electrical power transfer switches.
2. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches", and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL-listed and labeled.
3. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s ICS 2, "Industrial Control Devices, Controllers and Assemblies", ICS 6 and 250, pertaining to transfer switches.
4. NFPA Compliance: Comply with applicable requirements of NFPA 99; "Standard for Health Care Facilities", and NFPA 101; "Code for Safety to Life from Fire in Buildings and Structures", pertaining to transfer switches. NFPA 110, NEC (NFPA 70) for construction and installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver transfer switches and associated devices in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store transfer switches and associated devices in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

PART 2 - PRODUCTS

2.1 TRANSFER SWITCHES

A. General: Except as otherwise indicated, provide manufacturer's standard design, materials and components as indicated by published product information, designed and constructed as recommended by manufacturer for duty indicated, and as required for a complete installation.

B. Automatic Transfer Switches shall be provided with 4 poles, current ratings as indicated on the drawings, for a normal and emergency source of 3 phase, 4 wire, 60Hz with neutral bus. The transfer switch shall be braced to have a short circuit rating of a minimum of 65,000 RMS symmetrical amperes, and larger than the available fault current indicated on the one line diagram. The transfer switches shall be listed per UL Standard 1008 as a recognized

component for emergency systems and rated for total system load. The pickup voltage shall be adjustable from 85% to 98% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The switch is to be enclosed in a NEMA 1 type non-ventilated enclosure suitable for all mountings without derating. The neutral bus shall be fully rated for switch ampere rating unless otherwise noted

C. The automatic transfer switches shall be mechanically held, electrically operated type and suitable for continuous duty in an unventilated sheet metal enclosure without derating (NEMA Type A IEC Type PC). The transfer switches shall be inherently double throw so both sets of contacts move simultaneously when the switch is transferring. The transfer switches shall be mechanically interlocked to ensure only three possible positions-normal neutral and emergency.

D. All main contacts shall be silver alloy wiping action type. They shall be protected by arcing contacts in sizes above 400 amperes. Main contacts shall transfer in 1/6th of a second or less.

E. All switch and relay contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panels from the enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes.

F. All relays, control wiring and accessories shall be front accessible. The voltage sensing relays and all adjustable timers shall be capable of being adjusted, while energized, through calibrated dials. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to drop out and pick up level. The switch shall be capable of handling all classes of loads as required for the application.

G. Automatic transfer switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches, or parts thereof which had not been intended for repetitive switching are not acceptable. An overload or short-circuit shall not cause the transfer switch to go into neutral position.

H. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 15 seconds and factory set at 3 seconds.

I. The switch shall transfer the load to the emergency power system after the generator set reaches proper voltage and frequency. Time delay transfer to emergency power adjustable from 0 to 120 seconds (set at 5 seconds) shall allow the engine-generator set to stabilize before application of load.

J. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 15 minutes.

K. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 98% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal.

L. Each individual transfer contact switch shall be arranged to close a pilot contact to initiate remote starting of standby plant after specified time delay upon normal source failure or after drop in voltage on any phase to 80% or less. Upon signal from automatic transfer switch, engine shall crank, start, obtain operating speed and be ready to accept load within ten seconds. When the standby plant is delivering not less than 90% of rated voltage and frequency, the load shall be transferred. This operation shall take place within 10 seconds of the loss of normal power. Upon restoration of the normal source to not less than 90% of rated voltage on all phases, the load shall be transferred to the normal source after specified time delay. Upon retransfer to normal source, engine shall remain running for a predetermined time for "cool-out" and/or protection against additional failure of normal source.

M. Transfer switch shall be factory equipped with a means to prevent large inrush currents due to transfer between energized sources. This feature shall provide a field adjustable time delay during switching in both directions, during

which time the load is isolated from both power sources, to allow residual voltage of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The programmed transition feature shall have an adjustable time range of 0 to 7.5 seconds. All transfer switched specified to be supplied without programmed transition shall be capable of addition of the programmed transition feature in the field without transfer switch replacement. Transfer methods that use the phase relationships between the two power sources to control a transfer initiation time are not acceptable.

N. The automatic transfer switch shall be UL listed as complete transfer switch in accordance with UL 1008, latest edition. UL listing on the individual power switch devices above is not sufficient. Transfer switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches etc., will not be acceptable. The automatic transfer switch shall be warranted for a period of two years from date of acceptance.

O. A contact that closes when normal source fails for initiating engine starting, rated 10 amps, 32 volt D.D. Contacts to be gold plated for low voltage service.

P. Pilot lights to show switch position.

Q. One set of normally open and one set of normally closed auxiliary contacts.

R. A test switch to momentarily simulate normal source failure.

S. Harnessing between transfer switch and control panel shall have built-in disconnect for routine maintenance.

T. Transfer switch shall be furnished with an operator's manual providing installation and operating instructions.

U. Transfer switch shall be supplied in a NEMA 1 enclosure.

V. Transfer switch shall be furnished with an adjustable exerciser circuit. Selectable exercise time of the day of month, time of day, and duration shall be provided.

W. The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be a built-in microprocessor-based system for maximum reliability, minimum maintenance, and inherent digital communications capability. The control settings shall be stored in nonvolatile EEPROM. The module shall contain an integral programmable clock and calendar. The control module shall have a keyed disconnect plug to enable the control module to be disconnected from the transfer mechanism for routine maintenance. The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance. Interfacing relays shall be industrial control grade plug-in type with dust cover.

X. The control module shall include programming keypad, alpha-numeric display for monitoring settings and diagnostic values, key-lockable program selector switch, light-emitting diode status indications, and user instructions. These features shall be user accessible when the enclosure door is closed.

Y. The control module shall be capable of storing the following records in memory for access either locally (at the control module) or remotely (at a computer):

1. Number of hours transfer switch is in the emergency position (total and since record reset).
2. Number of hours the emergency is available (total and since record reset).
3. Total transfers in either direction (total and since record reset).
4. Date of record reset.
5. Date of last exercise period.
6. Date, time, and description of the last four source failures.
7. Elapsed time during the most recent source outage.

Z. The following additional accessories shall be provided:

1. Adjustable time delay to override momentary outage for six (6) seconds.
2. Adjustable time delay 2-25 minutes on retransfer to normal source with 5 minute unloaded running time of standby plant. In the event of a general failure transfer switch will nullify the time delay and return to normal.
3. Momentary test switch with the following positions:
   a. Test
   b. Automatic
4. Engine starting contact.
5. Indicating lights - mount in cover of enclosure to indicate switch in either normal or emergency position.
6. Auxiliary contacts, one closed on normal position, the second closed on emergency position.
7. All time delay and sensing functions shall be readily field adjustable over the ranges indicated and operate without drift over a temperature range of minus 4˚F. to 158˚F.
8. Time delay on transfer to emergency for controlled loading of generator 0-1 minutes, set at 0 minutes.
9. Return to normal switch - mount in cover of enclosure to initiate manual transfer from alternate to normal power source.

AA. During the withstand tests, there shall be no contact welding or damage. The circuit breaker coordination tests shall be performed without the use of current limiting fuses, and oscillograph traces across the main contacts shall be furnished to verify that contact separation has not occurred. Test procedures shall be in accordance with UL 1008, and testing shall be certified by Underwriters' Laboratories, Inc. or a nationally recognized Independent Electrical Testing Laboratory. When conducting temperature rise test to Paragraph 17 of UL-1008, the manufacturer shall include post- endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

BB. An operational test shall be conducted after installation to indicate that each switch will operate satisfactorily under all conditions required by the Specifications. This shall be done in the presence of the Architect's representative.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which transfer switches are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFER SWITCHES

A. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer’s written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.

B. Coordinate with other electrical work, including raceway, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.

C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torquing requirements are no indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

D. Anchor mounting hardware firmly to walls, floors, or ceilings, to ensure enclosures are permanently and mechanically secured. Provide all hardware and accessories for proper mounting.

E. Provide in conjunction with each and every automatic transfer switch the following:

1. 2# 12-1/2"C from auxiliary contact (closed when switch in emergency position) on transfer switch to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
2. 2# 12-1/2"C from auxiliary contact (closed before switch returns to normal power) on transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
3. 2# 12-1/2"C from engine start contact on transfer switch to respective emergency generator control panel.
4. 2# 12-1/2"C from auxiliary contacts on fire pump controller for generator start.
5. Wiring as necessary from transfer switch to remote annunciator panels and engine control panel for transfer switch position indicator lights.

F. Provide all necessary wiring and conduit to each remote alarm panel locate at the building command center.

3.3 GROUNDING

A. Provide equipment grounding connections for transfer switch units as indicated. Tighten connectors to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

A. Test transfer switches, by means of simulated power outage; automatic start-up by remote-automatic starting, transfer of load and automatic shutdown. Prior to these tests, adjust transfer switch timers for proper system coordination.

B. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of transfer switches with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting, where necessary, at no cost to Owner.

3.5 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating transfer switches an auxiliary equipment.

END OF SECTION

SECTION 26 41 15

LIGHTNING PROTECTION SYSTEM (MULTI-POINT)

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. This Section is coordinated with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to mechanical and Electrical Work.

B. Section 23 05 01 - Mechanical and Electrical Coordination shall apply.

C. Section 26 05 02 – Electrical Requirements.

1.2 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, a lightning protection system in accordance with specifications. The lightning protection system shall include, but not be limited to air terminals, loops, ground rods, connections, and wiring.

B. Any such work included in any other section of these specifications that is not specifically described therein shall comply with the requirements of this section.

C. The following items of work are specifically included in, but not limited to the generality implied by these specifications.

1. Lightning protection terminals.
2. Complete Terminal, Base and Supports.
3. Down Conductors.
4. Grounding Termination.
5. Transient Voltage surge suppression.

1.3 QUALITY ASSURANCE

A. "Manufacturers" - Firms regularly engaged in the manufacturer of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less then 10 years and are members of the Lightning Protection Institute.

B. A system of lightning protection shall be provided and installed in compliance with the provisions of NFPA 78, NEC and the latest "Code for Protection Against Lightning" for buildings as adopted by the National Fire Protection Association and the Underwriters Laboratories, Inc. to produce a Master Label System.

C. The lightning protection system shall be installed by a lightning protection contractor who specializes in this field.

1.4 SUBMITTALS

A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination and submit shop drawings. Shop drawings shall include a dimensioned drawing of lightning protection system layout with conductor routings, descriptive data on all equipment, air terminals, air terminal bases, cable fasteners, splicer fittings, ground clamps, and cables.

B. Submit detailed product data sheets showing application, dimensions, and material of each component utilized in the lightning protection system installation.

C. Submit manufacturer's installation instructions under the other provisions.

D. Submit proof of installer's approval or certification by the system manufacturer.

E. A sample of all parts to be used in the lightning protection systems shall be submitted for review and approval.

F. Submit copy of manufacturer's warranty.

G. Submit copy of lightning protection insurance policy for a minimum of $6,000,000 coverage.

H. Submit list of ten (10) verifiable installations with names, addresses, and phone numbers.

1.5 GUARANTEE

A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All material shall comply in weight, size and composition with the requirements of Underwriters Laboratories, Inc. and the National Fire Protection Association Code relating to this type of structure.

2.2 AIR TERMINALS

A. Air terminals shall be 1/2" x 18" solid copper and shall extend at least 18 inches above the object to be protected. All air terminal bases shall be cast bronze with stainless steel bolted-pressure cable connectors. The air terminals should be spaced so as not to exceed 20' apart around the outside perimeter of the roof or the ridge and not over 50 square feet apart through the center of flat roof areas. The air terminals in the center roof area shall be 1/2" x 48" solid copper with a proper brace. All air terminal bases for flat roof areas shall be of the adhesive type.

2.3 CONDUCTORS

A. Conductors shall consist of U.L. listed 28 strands of 14 gauge copper wire weighing 375 lbs. per 1,000 feet and installed in accordance with the U.L. Code. A perimeter cable shall be installed around the entire main roof, and all penthouses and cooling towers. Each perimeter cable shall be connected to at least (2) down leads, providing a two-way path to ground from each air terminal. All center roof air terminals shall be interconnected with conductors to the outside perimeter cable. Conductors on the flat roof areas may be run exposed. Ground connections shall be made around the perimeters of each roof and to the main down conductor at a maximum of 100'-0" on centers.

2.4 CONCEALED CONDUCTORS

A. All concealed conductors shall be installed in Schedule 40 1" P.V.C. Conduit. Conduit to be furnished and installed by the Electrical Contractor.

2.5 FASTENERS

A. Conductor fasteners shall be an approved type of non-corrosive metal, have ample strength to support conductors and shall be spaced not to exceed 3'-0" centers. Masonry type cable fasteners spaced every 3'-9" on masonry. Adhesive type cable fasteners spaced every 3'-0" on flat roofs.

2.6 ROOF PENETRATION

A. Wherever the conduit penetrates the roof, copper pitch pans shall be furnished by the Lightning Protection Contractor and installed by the Roofing Contractor. Wood nailing blocks shall be furnished and installed by the General Contractor. All patching and masonry work shall be furnished and installed by the General Contractor.

2.7 DOWN CONDUCTORS

A. Buildings that are of reinforced concrete or wall bearing structures, the concealed down conductors shall be installed in Schedule 40 1" P.V.C. Conduit. Each perimeter roof cable shall be connected to at least 2 down leads. The average distance between down leads shall not exceed 100', from upper roof to lower roof, or from roof to ground terminals. Irregularly shaped structures may require extra down conductors to provide a two-way path to ground from each air terminal.

2.8 CABLE CONNECTORS

A. All cable connectors shall be cast bronze with screw pressure type stainless steel bolts and nuts.

2.9 INTERCONNECTION OF METALS

A. All metal bodies within 6' of the conductor shall be bonded to the system with approved fittings and conductor. Connections between dissimilar metals shall be made with approved bimetallic connections.

1. Bonding of all metallic objects and systems at roof levels and elsewhere on the structure shall be complete. Primary bonds for metal bodies of conductance shall be bonded with appropriate fittings and full-size conductor; and shall consist of, but not be limited to the following: Roof exhaust fans, HVAC unit with related piping ductwork, exhaust vents and any other roof piping systems, cooling towers, and rails systems, window washing tracks, antenna mast for T.V., radio or microwave, flag poles, roof handrails and/or decorative screens, roof ladders, skylights, metal plumbing stacks, etc. Exterior architectural metal fascia and/or curtain walls or mullions, which extend the full height of the structure shall also be bonded, if not inherently bonded thru the building frame.
2. Metal bodies of inductance located within six feet of a conductor or object with secondary bonds, shall be bonded with secondary cable and fittings. Typical of these are: Roof flashings, parapet coping caps, gravel guards, isolated metal building panels or siding, roof drains, down spouts, roof insulation vents and any other sizeable miscellaneous metals, etc.

2.10 GROUNDING

A. Ground terminals shall be located at the base of the structure. Ground connections shall be made around the perimeter of the structure and in no case shall average over 100'-0" apart. Ground terminals shall be 3/4" in diameter and shall be driven to a minimum depth of 10' and more if necessary to reach permanent moisture. One ground shall have connection to the water system where the water supply enters the building in addition to artificial ground. In case of rock ledge or other conditions making it impossible to comply with the above, trenching or a copper ground plate will be permitted, providing it will meet with the Underwriters Laboratories, Inc. requirements.

2.11 COMMON GROUNDING

A. Provide necessary common grounds between the lightning protection system and the electric and telephone service entrance wires, TV and radio antenna grounds.

2.12 SURGE SUPPRESSION (Refer to Section 26 43 13 “Transient Voltage Surge Suppression)

A. Provide surge protection on the electrical, telephone, and antenna and TV lead wires.

B. The surge suppressor for the main electrical service entrance switches shall be 150 grade, rated for (160) KA capability, reaction time of less than five (5) nanoseconds, with redundant replaceable MOV modules, independently fused module, status indicator lights, UL 1449 listed. The electrical surge suppression equipment shall be installed at the main entrance of the electrical system with a UL listed disconnecting mechanism. The surge suppressor shall have the capability of being disconnected without shutting down the electrical system.

C. Electrical surge suppressers shall comply with requirements outline in the transient voltage surge suppression specification section.

D. Telephone surge suppression shall be to the standards of the telephone system carrier. The suppressor shall be industrial grade, with replaceable modules, and a reaction time of less than one (1) nanosecond. This surge equipment shall be installed at the main entrance of the telephone system.

E. Antenna and TV lead wire suppressor shall be industrial grade suitable for the conductor, coax or hard wire. The suppressor shall have a reaction time of less than one (1) nanosecond and shall be installed as close to the antenna or TV camera as possible.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine locations where grounding is to be installed and notify Architect/Engineer in writing of conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Excavating: All services involving excavating, trenching, backfilling, tamping of ground for ground rods, test wells, and ground loops shall be furnished and completed by the Contractor and meet the Architect's and Engineer's requirements.

B. Install lightning protection system in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purpose.

C. Coordinate with other work including electrical wiring, excavating, and roofing work, as necessary to interface installation of lightning protection system with other equipment.

D. Installation shall comply with the requirements of the NEC, NFPA No. 78, applicable UL installation requirements, UL Master Label requirements, and the applicable portions of NECA's "Standard of Installation".

E. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops. All conductor drops to earth shall be concealed in building structure.

3.3 FIELD QUALITY CONTROL

A. Upon completion of lightning protection system, test system to demonstrate compliance with requirements. When possible, field-correct defective equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

B. Inspect all connections prior to concealing same.

C. Check continuity of entire system.

D. Provide Master Label inspection verification.

E. Underwriters Laboratories, Inc. Master Label shall be furnished as evidence that the installation has met with UL 96A code requirements.

F. Upon completion of installation of lightning protection system, test ground resistance with a megger ground tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less by driving additional ground rods and/or treating soil around ground rod with sodium chloride (salt), calcium chloride, copper sulphate, or magnesium; then retest to demonstrate compliance.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

This specification includes requirements for a high energy surge protection devices and electronic filtering system used to protect AC electrical distribution from the effects of lightning, utility switching events, and impulses generated internally within a facility.

1.2 RELATED DOCUMENTS

The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1992
ANSI/IEEE C62.1 and C62.11
Canadian Standards (CUL)
Federal Information Processing Standards Publication 94 (FIPS PUB 94)
National Electrical Manufacturers Association (NEMA LS1-1992 Guidelines)
National Fire Protection Association (NFPA 70 [NEC], 75 and 78)
Underwriters Laboratories (UL 198, 248-1, 489, 1283 and 1449-latest Edition)

1.3 SUBMITTALS

A. Product Data: Provide complete product data detailing manufacturer's model number, specifications, features and options. Substitute/alternate products shall only be considered if the Attachment 1 Surge Protection Devices Submittal Compliance Form is fully completed and included in the submittal.

B. Test Data: Certified documentation shall be provided of the product's UL 1449 Latest Edition listing, clamping values (to include ratings with internal disconnects, if applicable), surge current fuse testing, independent test lab single pulse surge current capacity testing, and minimum repetitive surge current capacity testing.

C. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, field connections and mounting provisions.

D. Installation, Operation and Maintenance Manuals: Provide one copy of the installation, start-up, operation and maintenance data for each unit supplied.

1.4 SUBSTITUTION PRE-APPROVAL PROCEDURES

Manufacturers requesting approval of their products shall identify the full model number and submit product data, specifications and complete the Attachment 1 Surge Protection Devices Submittal Compliance Form at least fourteen (14) days prior to the bid date.

1.5 WARRANTY

The manufacturer shall provide a ten year limited warranty from the date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

1.6 LOCAL SERVICE SUPPORT

A dedicated support organization shall be located within 150 miles of the project location, and shall have experience supporting at least twenty other projects of similar complexity within the last three years. Personnel shall perform a start-up service to verify correct installation of the filters, perform transient voltage tests for reliability and performance using appropriate surge generating test equipment, and respond on-site to investigate user concerns.

PART 2 - PRODUCTS

2.1 HIGH PERFORMANCE SUPPRESSION SYSTEM

The suppression system shall incorporate metal oxide varistor (MOV) arrays and filtering capacitors. The system shall not utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

2.2 UL 1449 LATEST EDITION

The system shall be UL 1449 Latest Edition listed and UL approved as a surge protection device.

2.3 UNIT OPERATING VOLTAGE

The operating voltage and configuration shall be 277/480 grounded wye for unit substation location and 120/208 Volt grounded wye for panelboard locations or as noted on the drawings.

2.4 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

The MCOV shall be greater than 115 percent (%) of nominal voltage. Test and evaluation shall be as outlined in NEMA LS1-1992, paragraphs 2.2.6 and 3.6.

2.5 PROTECTION MODES

Per the definitions in NEMA LS 1-1992, paragraph 2.2.7, all modes shall be protected (e.g., line-to-line, line-to-neutral, line-to-ground and neutral-to-ground).

2.6 RATED SINGLE PULSE SURGE CURRENT CAPACITY

Calculations for single pulse surge current capacity shall use the component manufacturer's individual component rating multiplied by the respective number of per mode components. Documentation shall be provided with submittals on the Attachment 1 Surge Protection Devices Submittal Compliance Form. Component manufacturer's ratings shall be derived using the ANSI/IEEE C62.41-1991 Category C1 8 X 20/sec, 3000A current waveform. The per mode single pulse surge current rating shall be calculated based upon the component manufacturer's catalog rating for each device. The minimum rated single pulse surge current capacity per mode shall be as follows:

Rated Single Pulse Surge Current Capacity				
Location	L-N	L-G	N-G	L-L
Unit Substations	150,000 A	150,000 A	150,000 A	150,000 A
Panelboards	100,000 A	100,000 A	100,000 A	100,000 A

2.7 TESTED SINGLE PULSE SURGE CURRENT CAPACITY

The suppression filter system shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. Units with surge current capacities of 200,000 amps or less shall be tested as a unit, not individual modules. Due to industry test equipment limitations, units with surge current capacities greater than 200,000 amps shall be tested as a unit to 200,000 amps; and certified for surge current ratings above 200,000 amps by testing individual components or sub- assemblies within a mode. Units that sustain any component or overcurrent device failure are unacceptable.

2.8 MINIMUM REPETITIVE SURGE CURRENT CAPACITY

Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992, every mode of the suppression filter system shall be designed to survive multiple Category C3, 20 KV, 10 KA impulses. Test documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.

Repetitive Surge Current Capacity - Number of Impulses				
Locations	L-L	L-N	L-G	N-G
Unit Substation	>12,000	>12,000	>12,000	>12,000
Panelboards	>4500	>4500	>4500	>4500

2.9 SWELL VOLTAGE RATING

For unit substation locations only, suppression components shall be capable of withstanding continuous overvoltage events (swells). Based on a source impedance of 0.7 Ohms, the unit shall withstand an overvoltage of 200 percent (above RMS nominal voltage) for at least 60 cycles, without component failure (including fuses).

2.10 HIGH FREQUENCY EXTENDED RANGE FILTER

EMI-RFI noise rejection/attenuation (per NEMA LS-1-1992 and MIL-STD-E220A 50 ohm insertion loss methodology) shall be as follows:

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	50	41	31	35	53

For installations that install multiple downstream filters, the filters shall be coordinated to provide minimum noise rejection/attenuation as follows:

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	85	83	68	67	84

NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

2.11 SUPPRESSION VOLTAGE RATING

In compliance with procedures outlined in NEMA LS 1-1992, paragraphs 2.2.10 and 3.10, the maximum suppression voltage rating (with integral fused disconnect) shall be as follows:

System Voltage	Mode	6KV/500A Comb Wave	B3 Ringwave	B3/C1 Comb. Wave	C3 Comb. Wave
120/208	L-N L-G N-G L-L	325 325 325 625	350 425 375 475	425 500 475 825	725 800 750 1200
277/480	L-N L-G N-G L-L	725 750 700 1375	575 875 700 750	850 850 900 1675	1150 1175 1200 2100

2.12 REDUNDANT OVERCURRENT PROTECTION

Each suppression element shall utilize individual UL 248-1 recognized, 200 KAIC tested fuses to ensure that the operation of any single fuse does not isolate the filter from the distribution. At service entrance locations only, in the event a catastrophic or swell voltage occurrence causes the failure of all the MOV elements, the fusing for the selenium cells shall be independent to provide redundancy. The filter shall be capable of withstanding the rated single pulse surge current capacity without fuse failure.

2.13 INTERNAL CONNECTIONS

Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick-disconnect terminals shall be used in the surge current-carrying paths.

2.14 BUILT-IN FIELD TEST CAPABILITY

The unit shall incorporate an integral test point for off-line diagnostic testing to verify operational integrity of the suppression filter system. Testing shall include injection of an impulse at least two times the nominal system voltage, and provide metering to indicate the resultant clamping voltage.

2.15 ADDITIONAL FEATURES/EQUIPMENT

Advanced Monitoring Feature. A battery-powered audible alarm with event counter displays and two sets of form C dry contacts (N.O. or N.C.) shall be provided. The alarm shall indicate single or multiple phase failure of the filter.

PART 3 – EXECUTION

3.1 INSTALLATION

The Surge Protection Devices filters shall be installed within the switchgear as close as possible to the connection point following the manufacturer's recommendations for conductor size and minimal bends.

3.2 EQUIPMENT MANUAL

An equipment manual shall be provided that details installation, operation, and maintenance instructions for the filter. Information shall include unit dimensions, weights, mounting provisions, connection details and a layout diagram.

ATTACHMENT 1 – SURGE PROTECTION DEVICES SUBMITTAL COMPLIANCE FORM
(SERVICE ENTRANCE)

Performance/Feature	Specification Requirement	Proposed
Single Pulse Surge Rating Per Mode	150 KA L-N 150 KA L-G 150 KA N-G	_____ L-N _____ L-G _____ N-G
Single Pulse Surge Rating Per Phase	300 KA L-N + L-G	_____ L-N + L-G
Number Of Components Used For Above Rating (Attach Component Manufacturer's Product Data)	L-N: 16, L-G: 16; N-G: 16 Each component rated for 10,000 transient Amps (Manufacturer: Harris Ultra MOV V20E320)	Number of MOV's/Mode L-N _____ L-G _____ N-G _____
Warranty For Damage To Surge Protection Devices Due To Lightning	10 years	
Dispatch Location For Local Support And Start-Up		
Maximum Continuous Operating Voltage (MCOV) For All Suppression Components	Greater than 115 percent and less than 130 percent	
Protection Modes Provided	L-L, L-N, L-G and N-G	
Category C3 Repetitive Surge Current Capacity	> 12,000 impulses	
High Frequency Noise Filtering Attenuation	50 KHz 50 dB 100 KHz 41 dB 1 MHZ 31 dB 10 MHZ 35 dB 100 MHZ 53 dB	50 KHz ____ dB 100 KHz ____ dB 1 MHZ ____ dB 10 MHZ ____ dB 100 MHZ ____ dB
Internal Surge Current Path	Copper Bus Bar	
Built-In Field Test Capability	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes
Low Impedance Internal Disconnect	Required? _x_ No ___ Yes	Provided? ___ No ___ Yes
Dual Disturbance Counters	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes
Microprocessor-Based Diagnostics	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes

ATTACHMENT 1 – SURGE PROTECTION DEVICES SUBMITTAL COMPLIANCE FORM
(PANELBOARDS)

Performance/Feature	Specification Requirement	Proposed
Single Pulse Surge Rating Per Mode	100KA L-N 100KA L-G 100KA N-G	_____ L-N _____ L-G _____ N-G
Single Pulse Surge Rating Per Phase	200KA L-N + L-G	_____ L-N + L-G
Number Of Components Used For Above Rating (Attach Component Manufacturer's Product Data)	L-N: 11, L-G: 11; N-G: 11 Each component rated for 10,000 transient Amps (Manufacturer: Harris Ultra MOV V20E320)	Number of MOV's/Mode L-N _____ L-G _____ N-G _____
Warranty For Damage To Surge Protection Devices Due To Lightning	5 years	
Dispatch Location For Local Support And Start-Up		
Maximum Continuous Operating Voltage (MCOV) For All Suppression Components	Greater than 115 percent and less than 130 percent	
Protection Modes Provided	L-L, L-N, L-G and N-G	
Category C3 Repetitive Surge Current Capacity	> 4500 impulses	
High Frequency Noise Filtering Attenuation	50 KHz 50 dB 100 KHz 41 dB 1 MHZ 31 dB 10 MHZ 35 dB 100 MHZ 53 dB	50 KHz ____ dB 100 KHz ____ dB 1 MHZ ____ dB 10 MHZ ____ dB 100 MHZ ____ dB
Internal Surge Current Path	Copper Bus Bar	
Built-In Field Test Capability	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes
Low Impedance Internal Disconnect	Required? _x_ No ___ Yes	Provided? ___ No ___ Yes
Dual Disturbance Counters	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes
Microprocessor-Based Diagnostics	Required? ___ No _x_ Yes	Provided? ___ No ___ Yes

END OF SECTION

SECTION 265100 - ARCHITECTURAL LIGHTING

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. WORK OF THIS SECTION SHALL BE GOVERNED BY THE CONTRACT DOCUMENTS. PROVIDE MATERIALS, LABOR, EQUIPMENT, AND SERVICES NECESSARY TO FURNISH, DELIVER, AND INSTALL ALL WORK OF THIS SECTION AS SHOWN ON THE DRAWINGS, AS SPECIFIED HEREIN, AND/OR AS REQUIRED BY JOB CONDITIONS.

B. THE WORK SHALL INCLUDE BUT NOT BE LIMITED TO THE FOLLOWING:

1. COMPLETE SHOP FABRICATION
2. DELIVERY TO JOB SITE
3. INSTALLATION AT DESIGNATED LOCATIONS, AND CONTROLS AS NOTED
4. LAMPING AND LAMPS
5. LAMP FOCUSING
6. CLEANING AND PROTECTION

1.2 DESCRIPTION OF WORK

A. FURNISH AND INSTALL A LIGHTING FIXTURE OF THE TYPE INDICATED BY LETTER AT EACH LOCATION SHOWN ON THE DRAWINGS.

B. ALL MATERIALS, ACCESSORIES, AND ANY OTHER EQUIPMENT NECESSARY FOR THE COMPLETE AND PROPER INSTALLATION OF ALL LIGHTING FIXTURES INCLUDED IN THIS CONTRACT SHALL BE FURNISHED BY THE CONTRACTOR.

C. CONFORMANCE: FIXTURES SHALL BE MANUFACTURED IN STRICT ACCORDANCE WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS.

D. CODES: MATERIALS AND INSTALLATION SHALL BE IN ACCORDANCE WITH THE LATEST REVISION OF THE NATIONAL ELECTRICAL CODE AND ANY APPLICABLE FEDERAL, STATE, AND LOCAL CODES AND REGULATIONS.

E. ALL FIXTURES AND COMPONENTS OF SHALL BE MANUFACTURED IN ACCORDANCE WITH THE APPROPRIATE AND CURRENT REQUIREMENTS OF A NATIONALLY RECOGNIZED TESTING LABORATORY (UL, CUL, ETL, OR OTHERS) –OR– AN EUROPEAN ECONOMIC AREA APPROVED CE TESTING LABORATORY AND HAVE APPROPRIATE LABELING AFFIXED TO EACH FIXTURE IN A POSITION THAT IS CONCEALED FROM NORMAL VIEW.

F. SPECIFICATIONS AND SCALE DRAWINGS ARE INTENDED TO CONVEY THE SALIENT FEATURES, FUNCTION AND CHARACTER OF THE FIXTURES ONLY, AND DO NOT UNDERTAKE TO ILLUSTRATE OR SET FORTH EVERY ITEM OR DETAIL NECESSARY FOR THE WORK.

G. MINOR DETAILS, NOT USUALLY INDICATED ON THE DRAWINGS NOR SPECIFIED, BUT THAT ARE NECESSARY FOR THE PROPER EXECUTION AND COMPLETION OF THE FIXTURES, SHALL BE INCLUDED, THE SAME AS IF THEY WERE HEREIN SPECIFIED OR INDICATED ON THE DRAWINGS.

H. OMISSIONS: THE OWNER SHALL NOT BE HELD RESPONSIBLE FOR THE OMISSION OR ABSENCE OF ANY DETAIL, CONSTRUCTION FEATURE, ETC. WHICH MAY BE REQUIRED IN THE PRODUCTION OF THE FIXTURES. THE RESPONSIBILITY OF ACCURATELY FABRICATING THE FIXTURES TO THE FULFILLMENT OF THIS SPECIFICATION RESTS WITH THE CONTRACTOR.

1.3 RELATED DOCUMENTS

A. The Specifications and Drawings are intended to be complementary.

1. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished.

2. Drawings are diagrammatic and may not show all of the work required or all construction details. All dimensions and actual placements are to be verified in the field.

B. Refer to Section 265101 - appendix (a) for lighting fixture schedule

1. Any discrepancies between the catalog numbers, fixture description, remarks, lamp and supply voltage should be brought to the attention of the Project Arhitect prior to the release of a purchase order.

C. Refer to Section 265101 - appendix (b) for lighting fixture cut sheets

1. Catalog cuts or "series" numbers are intended to provide assistance in establishing general type or category of lighting fixtures only. Contractor shall provide a fixture that meets the written performance and description.

1.4 REFERENCE STANDARDS

A. National Electrical Code

B. National Electrical Manufacturers Association (NEMA)

C. National Fire Protection Association (NFPA section 70)

D. American National Standards Institute (ANSI)

E. Illuminating Engineering Society (IES):

F. Aluminum Association (AA)

G. American Iron and Steel Institute (AISI)

H. Restriction of Hazardous Substances in LED (RoHS)

I. Certified Ballast Manufacturers Association (CBM)

PART 2 – PRODUCT DATA

2.1 FIXTURE CONSTRUCTION (GENERAL)

A. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and be effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.

B. Sheet Metal Work: All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion after assembly.

C. Housings shall be so constructed that all electrical components, including power supply units (ballasts / drivers) are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.

D. Castings: All castings shall be exact replicas of the approved patterns and shall be free of sand pits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of the metal castings in order that the finished castings will accurately fit in their designated locations.

E. All lamp sockets in lighting fixtures shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for lamp specified. If different socket positions are specified for same fixture, sockets shall be preset for each type, and cartons marked accordingly.

F. All fixtures shall be completely wired at the factory.

G. All fixtures supplied for recessing in suspended ceilings shall be supplied with prewired junction boxes.

H. Mounting Frames and Rings: If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.

I. There shall be no light leaks between ceiling trims of recessed lighting equipment and the ceiling. Fixture is used in partially transparent ceilings shall have no light leaks above the ceiling line.

J. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be furnished and installed by the Contractor.

K. Hardware:

1. Steel and aluminum fixtures: all screws, bolts, nuts and other fastening and latching hardware shall be cadmium or equivalent plated.
2. Stainless steel fixtures: all hardware shall be stainless steel.
3. Bronze fixtures: all hardware shall be stainless steel or bronze.

L. Temperature: All fixtures must operate within the temperature limits of their design and in the applications and mounting conditions herein specified.

M. Adjustable Angle Fixtures: Each lighting fixture which has a beam angle adjustment shall have reliable angle locking devices.

N. Spread Lens Fixtures: Each light fixture which has a spread lens shall contain lens orientation locking devices to insure that lens orientation is not disturbed during future lamp replacement or cleaning.

2.2 REFLECTORS

A. Installation: Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.

B. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years, and, in the event of premature discoloration, shall be replaced by the Manufacturer, including materials and the cost of labor. Reflectors for fluorescent fixtures using tri-phosphor lamp technology shall not produce a visible "rainbow" of light.

C. Aluminum reflectors shall be finished specular, semi-specular, or diffuse as required and shall meet or exceed Alzak specifications. Minimum requirements of reflector finishes for interior and exterior service shall be as follows:

Minimum·weight·of·coating·per·description·of·service.¤	Minimum·reflectance·per·square·inch.¤	Specular¤	Diffuse¤
Normal·interior·commercial·service.¤	5.0¤	83.0¤	75.0¤
General·interior·industrial·and·exterior·work·reflector·protected·by·glass·covering.¤	7.5¤	82.0¤	73.0¤
Exterior·industrial·and·commercial·reflector·not·protected.¤	10.0¤	78.0¤	75.0¤
Exterior·marine·service·reflector·not·protected.¤	13.0¤	78.0¤	65.0¤

2.3 LENSES

A. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Evonik Industries or as acceptable. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

B. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be tempered for high impact and heat resistance. The glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass tempered Corning #7740 or as acceptable. For fixtures directly exposed to the elements and aimed above the horizontal with a radiant energy of 4.16 watts per square inch or greater, use Vycor glass or as acceptable.

C. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.

D. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

E. All lenses shall be turned over to the Owner clean and free of dust.

2.4 LAMPS:

A. Manufacturer: Lamps shall be manufactured by General Electric, Philips, or Osram/Sylvania unless different manufacturer is specified. All lamps of a given fixture designation and lamp type shall be supplied by the same manufacturer unless otherwise noted,.

B. If a specific manufacturer is noted in the schedule, only that manufacturer shall be acceptable.

C. Provide lamps for all lighting fixtures (furnished as part of the electric work).

D. Incandescent and tungsten halogen lamps shall not be operated, other than for initial testing, prior to final inspection, lighting control programming and/or turnover of finished space to owner. If incandescent or tungsten halogen lamps are operated by the contractor during construction, all lamps must be replaced by the contractor prior to owner turn over.

E. Compact fluorescent, linear fluorescent, and LED lamps shall not be operated, during construction, other than for initial testing, inspections, or control system programming, for a period of more than two (2) months prior to turn over of the finished space to the owner. If lamps are operated longer than two (2) months prior to owner turn over, all lamps must be replaced by the contractor.

2.5 LAMP HOLDERS:

A. Incandescent:

1. Body: porcelain;

2. Screw Shell: nickel plated brass, pre-lubricated with silicone compound.

B. Outdoor lampholders, when directly exposed to the elements, shall be neoprene gasketed and compression type.

C. Lampholders with open-circuit voltage over 300 volts shall be “safety” type, designed to open supply circuit on lamp removal.

2.6 FINISHES

A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350° Fahrenheit minimum, catalytically or photo-chemically polymerized after application.

B. White finishes: minimum of 85 percent reflectance.

C. Ceiling opening frames shall either be manufactured of non-ferrous metal, or be suitably rustproofed after fabrication.

D. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.

E. Undercoat: Except for stainless steel give ferrous metal surfaces a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

F. Unpainted non-reflecting surfaces shall be satin finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

G. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg. per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg. per square inch, of a color and surface finish as selected by the Architect.

2.7 INCANDESCENT LIGHTING FIXTURES:

A. Fixtures utilizing tungsten halogen sources shall:

1. Be designed and constructed so that lamp seal temperatures do not exceed 350°C at an ambient of 25°c when tested in accordance with UL Standard #57, and shall maintain an operating bulb wall temperature of approximately 600°C, and not less than 250°C.

2. Utilize lead wires be rated for not less than 200°C operation, but rated for 250°C if temperature warrants.

B. Temperature on reflectors shall not exceed 205°C at any point.

2.8 LED LIGHTING

A. Luminaire manufacturers shall only utilize LEDs that have been tested and comply with the relevant standards.

B. Testing shall be in accordance with

1. ASTME methods

2. IESNA current LM-79 standards by an independent DOE approved participating lab

C. LED chip manufacturers' recommended specifications shall be adhered to:

1. Power to the LEDs shall not be overdriven

2. Thermal characteristics of the luminaire coupled with the specified current shall not exceed acceptable temperature.

3. The fixture shall be designed to maintain LED junction temperatures below the specified maximum temperature.

D. All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.

E. LED color

1. Consistency for static white LEDs shall not exceed 3 SDCM (3 stem MacAdam binning)

2. CRI shall be at least 80 with an R9 value greater than (80) - unless otherwise specified on the fixture schedule.

3. The average color shift shall be less than 0.0026du'v' after 10,000 hours; 0.007du'v' after 60,000 hours (based on LM80)

F. Luminaire shall exhibit 50,000 hours of life to 70% lumen output (based on LM-80 and extrapolated via the TM-21 calculation from 9000 hours of data at the testing temperature - unless otherwise specified on the fixture schedule.)

2.9 INSTRUCTIONS:

A. Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install.

2.10 BASE BID MANUFACTURERS (ALTERNATES)

A. Alternate manufacturers:

1. Subject to compliance with requirements, other manufacturer's products may be found acceptable

B. Base bid shall be for lighting fixtures of manufacturers listed in the Fixture Schedule

1. Identification by means of manufacturers' names and catalog numbers is to establish basic features and performance standards. Any substitutions must meet or exceed the base bid standards.

C. Products specified to be by a designated manufacturer with "or equal by" an alternate manufacturer:

1. The alternate manufacturer's product must meet the specifications given for the designated product. If the alternate manufacturer listed does not have a product that will meet the specification, then his product will not be acceptable.
2. For any fixture offered in substitution for a specified fixture, provide complete photometric data

D. It is the contractor's responsibility to verify that the alternate manufacturer's equipment is complete with the same features, options, and photometric performance, as the designated manufacturer's equipment, and that it will fit in the available space (wall, plenum, cove, etc.)

E. Substitutions:

1. Within sixty days of placement of order, Contractor must furnish independent photometric tests and samples for all alternative fixtures.
2. If fixture fails to comply with specification requirements at that time, Contractor will furnish acceptable fixture at no additional cost to the Owner, and with no delay to the project.

2.11 ATTIC STOCK

CONTRACTOR MUST PROVIDE ATTIC STOCK OF ALL FIXTURES AND COMPONENTS AS DESCRIBED IN THE FIXTURE SCHEDULE.

A. Submittals must note the quantities of attic stock provided by the Contractor for each fixture type for approval.

B. Contactor to keep fixtures in original packaging and label all boxes with fixture type, manufacturer, catalog number, beam spread, color temperature and wattage. Attic stock fixtures must be stored in a temperature controlled location between 55° and 85° Fahrenheit. Owner to advise contractor of attic stock storage location.

2.12 SUBMITTALS:

A. The Contractor shall coordinate all aspects of the lighting fixture package and installation with the drawings and details of the Architectural, Structural, Electrical, Mechanical, and all other related trades.

B. No variation from the general arrangement and details indicated on the drawings shall be made in the submittal unless required to suit the actual conditions on the premises, and then only with the written approval of the Architect.

C. Submittal document(s) for all lighting fixtures shall be received no later than sixty days after award of Contract.

D. Review of shop drawings or samples does not waive contract requirements.

E. Provide manufacturer’s product data sheets for each type of lamp specified, including and highlighting the following product data:

2.13 SHOP DRAWINGS:

A. Provide for each fixture type submitted clearly indicated and complete “fixture type specific” ordering code.

B. Narrative descriptions, TDA cut sheets and verbatim copies of TDA catalogue numbers, and submittals that do not include manufacturer’s current submittal sheets are not acceptable for review.

C. Catalogue cuts lacking sufficient detail to indicate compliance with contract documents will not be acceptable.

D. Manufacturer's shop drawings:

1. Must be provided for all fixture components. Include detailed information on the fixture housing / mounting tray, mounting accessories, power supplies, and any other significant component of the fixture assembly and installation
2. Shop drawings should include:
    a. Details and cut sheets of each fixture type
    b. Clearly indicated fixture tag (Type designation)
    c. Lamping / source details
    d. Power requirements (input voltage and wattage)
    e. Power Supply Unit (PSU) details (when relevant)
    f. Graphic diagrams of all major fixture components, with overall fixture dimensions, and all other relevant technical details (ex: housing construction, optics, lenses, accessories, baffles, method of support, power feed locations, gasketing, fixture and housing finish, and others.)
    g. Contractor's field verified overall run lengths, layouts, and details that have been fully coordinated (with site conditions, construction by "others", etc.), when relevant.
        1) All non-standard layouts must be clearly documented, coordinated, and verified with field conditions, and any architectural integration as appropriate.
        2) Submit reflected ceiling plans, sections and/or details clearly identifying and locating each iteration of the fixture in the shop drawing
    h. Any modified fixtures must be so noted, and include Manufacturer's fabrication drawings and/or Manufacturer's statement demonstrating a clear understanding of the requirements and documentation of the product as it will be provided.
    i. Photometric data;
        1) For all optical fixtures supply complete photometric data for the fixture, including optical performance rendered by independent testing laboratory, developed according to methods of U.S.A. Illuminating Engineering Society
        2) Fixtures used for general illumination, photometric data shall include:
            a) Coefficients of utilization.
            b) Candlepower data:
                - Presented graphically and numerically in 5 degree increments.
                - For all "up/down light" fixtures and fixture with asymmetrical light distribution, present additional values at normal, parallel, and at 22-1/2°, 45°, 167-1/2° to the fixture
            c) Zonal lumens stated numerically in 10 degree increments
        3) Area and roadway luminaires, photometric data shall include:
            a) Isocandela charts
            b) Coefficients of utilization
            c) IES Roadway distribution classification

j. Custom fabrications shall clearly indicate the contract drawing number of fixture details used as reference in the development of the fixture, the name of the job, and of the Architect.

k. Indicate work to be provided by other trades

l. Indicate wiring and control circuits.

m. Indicate supplementary support when required to meet seismic code requirements.

2.14 SAMPLES:

A. For final approval after initial qualifying shop drawing review, and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture on the fixture schedule and contract drawings for which sample requirement is noted.

B. Shipping: The samples shall be complete with specified lamp(s), ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Architect, or as otherwise advised.

C. Sufficient time shall be allowed for thorough examination of the samples by the Architect.

D. Samples are not returnable, nor included in quantities listed for a project.

E. Samples must be actual working unit of materials to be supplied.

2.15 QUALIFICATIONS

A. The Manufacturer shall be a specialty lighting firm who has been in the business of designing and manufacturing specialty lighting fixtures for not less than ten (10) years.

B. Ballast manufacturers shall have been producing electronic ballasts in the U.S. for more than 10 years with a low failure rate.

C. Ballast shall carry three-year warranty, including labor allowance.

2.16 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name, and manufacturer's name. Delivered material shall be identical to the reviewed submittals.

B. Store materials under cover in a dry and clean location, off the ground. Remove materials which are damaged, or otherwise not suitable for installation from the job site and replace with acceptable materials.

C. The fixtures shall be delivered to the job site fully fabricated and assembled and ready for installation. Lamps shall be shipped separately.

D. For luminaires incorporating Alzak cones or reflector/cones for protection pending completion of the installation: these components shall be supplied bulk packed in cartons separate from the luminaires. Unit packaging of cones or reflector/cones with luminaires is not acceptable.

2.17 WARRANTY

A. Warranties shall be provided in an acceptable form and shall be signed and notarized by a person or persons authorized to execute such a document on behalf of the company.

1. The Manufacturer shall guarantee all lighting fixtures and major components (except replaceable incandescent, halogen, fluorescent, and discharge lamps) for a period of three (3) year after acceptance of the project and final payment is made.

2. Ballast shall carry three (3) year warranty, including labor allowance.
3. Drivers (for LED fixtures) shall carry five (5) year warranty, including labor allowance

2.18 CLOSE OUT SUBMITTALS

A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance manual including:
1. Tools required.
2. Types of cleaners to be used.
3. Replacement parts identification lists.
4. Final, as-built shop drawings.

PART 3 – EXECUTION

3.1 QUALIFICATIONS

A. The Installer, if not the manufacturer, shall be a firm having trained personnel who have been in the business of installing specialty lighting for not less than seven (7) years and shall provide a full time field superintendent who shall be a representative of the installer during the installation and testing.

3.2 INSTALLATION

A. Do not scale electrical drawings for exact location of the lighting fixtures. In general, the architectural reflected ceiling plans indicate the proper locations of lighting fixtures.

B. Install each fixture properly and safely, fixtures in strict conformance with manufacturer's recommendations and instructions.

C. Appurtenances:
1. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.
2. Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

D. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized to conceal the outlet box.

E. Secondary voltages shall be tested at the power supply unit, the connection to the fixture, and such other locations on the distribution system as necessary. The inductance at the point of connection to the fixtures must be within the manufacturer’s allowable range.

F. Install reflector cones, baffles, aperture plates, light controlling element for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

G. Replace blemished, damaged or unsatisfactory fixtures as directed.

H. Mechanical Rooms: Lighting fixture locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment.

3.3 AIMING AND ADJUSTMENT:

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Subcontractor under the supervision of the Architect. The Architect shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the Contractor at the direction of the Architect. As aiming and adjusting is completed, locking set-screws and bolts and nuts shall be tightened securely.

B. Night Work: Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing, aiming shall be accomplished at night.

3.4 CLEANUP:

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative.

3.5 INSTALLATION CHECKOUT:

A. Upon completion of initial installation and fixture cleaning, the Contractor shall notify the Architect that the installation has been completed. At this time, the Contractor shall verify that the installation has been done in full accordance with the design and specification and is in full and complete working order.

3.6 WARRANTY:

A. The Contractor shall warrant the fixture, its finishes, and all of its component parts, except ballasts, to be free from defects for a period of one year from date of acceptance if operated within rated voltage range. Replacement of faulty materials and the cost of labor required to make the replacement shall be the responsibility of the Contractor.

END OF SECTION 265000

SECTION 26 51 00

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including general and supplementary conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

C. Refer to Drawings for light fixture cutsheets.

1.2 SUMMARY

A. Extent, location, and details of lighting fixture work are indicated on drawings and in schedules.

B. Types of lighting fixtures in this section include the following:

1. Light Emitting Diode, LED
2. Other lamps as noted on fixture schedule.

C. Fixture: A complete lighting unit, including lamps, wiring, controls and parts required to securely support fixture.

D. Exact ceiling construction shall be verified prior to ordering. Minor changes in ceiling construction shall not be an extra cost to the project.

1. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.
2. Fixtures shall be manufactured in strict conformance with the Contract Drawings and Specifications.
3. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary of the work.
4. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the drawings.
5. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

E. Where a catalog number and a narrative or pictorial description is provided, the written description shall take precedence and prevail.

F. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

G. The contractor shall include the installation of an additional (20) exit signs with back boxes and conduit (with batteries if no generator) circuited and operational, in the base price for future request for exit signs by the Fire Department or Building Official. Place in field as directed.

H. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:

1. Fixture performance is equal or improved.
2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
3. Cost to the Owner is reduced or equal.
4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.3 SUBMITTALS

Submit shop drawings, samples, and prototypes as specifically instructed below.

A. Shop drawings shall include but not be limited to:

1. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification). If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
2. For lamps, submit catalog cut sheets prepared by the manufacturer which clearly shows, manufacturer, CRI, CT, wattage, base type, lumen output, lamp life, and any other pertinent information.
3. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamp layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required.
4. For all submittals under paragraphs 1 through 3 above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
5. The Architect/Engineer shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.
6. Maintenance Data: Submit maintenance data and parts list for each lighting fixture, accessory and also include “trouble-shooting” maintenance guide. In addition to the product data and shop drawings, a maintenance manual in accordance with general requirements of Division 1 shall be provided.

B. Samples:

1. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in LIGHTING FIXTURE SCHEDULES or as stated herein. When samples are called for the manufacturer shall provide two working samples, unless otherwise noted, complete with lamp, ballast (rated for 120 volt operation) and 6’ pig-tail 3-prong Edison plug.
2. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Sample fixtures may not be used on the project.
5. In the event the submissions are disapproved, the fixtures will be returned to the contractor to immediately make a new submission of fixture or fixtures meeting the contract requirements.
6. All costs associated for samples are to be paid by the Contractor. No additional costs to the Owner for samples or mockups will be allowed.

C. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.

D. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Architect. All variations must be clearly marked as such on the drawings submitted for approval.

E. Mock-ups:

1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture descriptions. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect. A minimum of five (5) mock ups are anticipated.
2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

F. Substitutions: Manufacturers or light fixtures not listed on fixture schedule must be prequalified prior to bid. For approval of all manufacturer/fixture substitutions, the bidders shall comply to specifications herein and as outlined below for submitting alternate fixtures:

1. No substitutions shall be accepted when the LIGHT FIXTURE SCHEDULE includes a three name manufacturer specification.
2. Should only one manufacturer be listed, with no "Approved alternate" statement, no substitutions are allowed. It is accompanied by a dollar allowance to allow for budgeting by other providers.
3. Light fixture bids must be priced separately and shall not be bundled with any other material or product bids, including but not limited to lighting control devices and lighting control systems.
4. Manufacturer shall have not less than five years experience in design and manufacture of lighting fixtures of the type and quality shown. Prequalification submissions must include a list of completed projects and data catalogue pages and drawings indicating length of experience.
5. Bidders wishing to obtain approval on brands other than those specified by name and catalog number or as an approved alternate in LIGHTING FIXTURE SCHEDULE shall submit their requests not later than fifteen (15) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved, as equal to those specified as far as the requirements of the project are concerned.
6. If the bidders do not elect to obtain prior approval during the time so specified above, the Owner/Architect/Engineer or Lighting Designer has no obligation to review or consider any such article after the contract award.
7. Contractor shall pay professional fees at current standard hourly rates and reimburse expenses directly to all designers (Architect, Engineer and Lighting Designer) for time spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
8. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Engineer. The fixture samples shall be furnished and installed at the bidder's expense, at a location selected by the Architect. In addition, the bidder shall furnish the Architect and the Engineer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Architect and the Engineer.

9. Point by point lighting calculations of areas affected by proposed substitution will be done by the bidder for review.
10. The Architect and Engineer shall determine whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.
11. When required and requested by the Architect, or Engineer, samples submitted as per above shall be subjected to photometric, thermal, mechanical, electrical or water testing at an independent test laboratory at no expense to the Owner.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with lighting fixture work similar to that required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 225, 250, 410, and 500 as applicable to installation and construction of building lighting fixtures.
2. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No's LE 1 and LE 2 pertaining to lighting equipment.
3. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office lighting. Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
4. UL Compliance: Comply with UL standards, including UL 486A and 486B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed and labeled.
5. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturer's Association standards and carry the CBM label.

D. Special Listing and Labeling: Provide fixture for damp locations, wet locations, recessed in rated ceilings and walls, hazardous that are UL listed and labeled for specific use. Fixtures mounted with air plenum spaces shall be rated for such conditions.

E. Materials and Equipment:

1. Materials, equipment, and appurtenances as well as workmanship provided under this Section shall conform to the highest commercial standards, and as specified and as indicated on drawings. Fixture parts and components not specifically identified or indicated shall be made of materials most appropriate to their use or function and as such resistant to corrosion and thermal and mechanical stresses encountered in the normal application and function of the fixtures.
2. All fixtures shall be manufactured to a consistent level of quality. Size, color, and component parts shall be identical for all fixtures of the same type.
3. Provide lighting fixtures whose performance under specified conditions is certified by the manufacturer.
4. Provide lighting fixtures, ballasts, and lamps produced by a manufacturer listed as an Approved Manufacturer in this section, or noted on the drawings.

1.5 DELIVERY, STORAGE, HANDLING, AND WARRANTY

A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.

B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperature, humidity, laid flat and blocking off ground.

C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

D. Provide a 5-year warranty of failure in materials, workmanship, ballast, etc., in addition to and not limited to other rights the Owner may have under the contract documents. A full warranty shall apply for the first year, and a prorated warranty for the last four years.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways to properly interface installation of lighting fixtures with ceiling requirements.

B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise specified or indicated on the Drawings, all incandescent fixture spinnings and stampings shall be (22) U.S. gauge. All spinnings and stampings shall be perfect and of even bore and gauge, shall be free from dents, scabs, fold or other defects. Incandescent lamp sockets shall have porcelain housings over copper screw base shells, with medium base sockets rated 660 watts at 250 volts. Wiring channels shall be in accordance with the National Electrical Code. All parts of the fixtures shall be accurately and firmly fitted in an approved manner. Where screws are necessary for adjustment, they shall be concealed as far as possible and finished to match the fixtures.

B. Set screws shall be heavy and of exact bore to fit the stems. Canopy and other set screws shall be large with a bearing of not less than four (4) full threads. All screws in all parts of fixtures shall be brass and of ample and approved size and strength for the purpose intended.

C. All glassware called for on the Drawings shall be furnished and put in place under this Division. Contractor shall be solely responsible for all glassware furnished by him, until the work has been accepted, and he shall leave the work with all glassware in perfect condition and thoroughly clean. Glassware shall be Opal, Carrara, Alba, Corning, Holophane.

2.2 MANUFACTURERS

A. The Contractor shall base bid for lighting fixtures on the manufacturers listed on the fixture schedule only.

B. Alternate manufacturer’s identification by means of manufacturer’s names is to establish basic features and performance standards. Alternate manufacturer’s or substitutions must meet or exceed the standards of the primary manufacturer listed.

C. Qualifications: The contractor is allowed 60 days after the contract has been awarded to submit independent photometric tests and samples for all alternate fixtures. If these fixtures fail to comply with the specification requirements at that time, the Contractor will furnish acceptable fixtures at no additional cost to the Owner and with

no delay to the project.

D. Any submittals for cost reduction alternates or value engineering shall include unit prices for the specified manufacturer, the specified equal manufacturer, and the proposed alternates. Refer to Part 1.3 for approval process.

2.3 CUSTOM FIXTURES MATERIAL, FABRICATION AND FINISHES (IF REQUIRED)

A. Provide materials as specified with the following characteristics:

1. Stainless Steel:
   a. AISI Type 302 or UNS Type S30200 18-8 grade: 18 percent chromium and 8 percent nickel. Austentic grain structure with excellent corrosion resisters and high strength.
   b. AISI Type 316: Most resistant to salt spray and industrial fumes for use in these applications.
   c. AISI Type 430: Most economical Ferritic Chromium Steel, very good corrosion resistance, for use only where specified.
2. Galvanized Steel: Coated steel with zinc by a method of hot dipping on electroplating.
3. Aluminum: A pure metal. Aluminum and aluminum alloys meeting the national standard ANSI H35.1-1982.
4. Bronze: Copper alloy, principal alloying elements are phosphor, aluminum, silicon, and tin.
5. Brass: Copper alloy, principal alloying element is zinc. Wrought brass is of UNS designation C20000, C30000, C40000, C66400 to C69800. Cast brass includes leaded red brass (C83600), leaded semi-red brass (C84400), and yellow and leaded yellow brass (C85200 to C85700).
6. Copper: A pure metal. Copper or high copper alloy containing less than 6 percent alloying elements. Wrought copper has UNS designation C10000. Cast copper has UNS designation C80100 to C82800.
7. Zinc: A pure metal. May be specified as an alloying element in copper and aluminum.
8. Glass: All glass shall be heat strengthened (tempered) clear float glass should conform to the requirements of Federal Specification DD-G-1403B, transmittance not less than 88 percent or laminated safety glass. For exterior fixtures, use Borosilicate glass, tempered, Corning #7740. For fixtures directly exposed to the elements and aimed above horizontal with radiant energy of 4.16 watts per square inch or greater, use Vycor glass.
9. Acrylic: 100 percent virgin acrylic polymer, colorless.
10. Neoprene: All neoprene rubber should be heat resistant to withstand heat generated by lamp operation.
11. Silicone: A plastic based on silicon which is not an organic compound. Suitable for use in a wide temperature range (-80 to +500ºF). Used as an additive to plastic to improve adhesion, increase strength, and improve water resistance.

B. Provide thickness of metal required or as specified so that all fixture are rigid, stable and will resist deflection, twisting, warping or bending under normal installation procedures, loading, relamping, etc.:

1. All steel luminaire housings minimum (22) gauge cold rolled steel.
2. All aluminum extrusion housings minimum 0.125” thick.
3. All spun, hydroformed, or sheet aluminum reflectors fabricated from #12 aluminum sheets, minimum 15 gauge, 0.57” or heavier.
4. All cast aluminum or bronze housings minimum of 0.375” thick.
5. All sheet bronze, steel, aluminum or other metal plate minimum of (22) gauge.
6. Flexible leads shall enter all fixtures at sides only, unless otherwise noted. Ballast compartments shall be well ventilated and ballast shall be firmly secured to conducting metal surface. Ballast screws shall be welded securely to fixture body.

C. Fasteners shall be manufactured of non-magnetic stainless steel, except in indoor applications where galvanized steel is acceptable in non-visible locations. Provide tamperproof screws in all fixtures mounted below 8’ above finished floor.

D. Refer to other parts of this section for additional material and fabrication requirements.

E. Fixture finishes shall be applied in a manner that will assure a durable, wear resistant surface.

1. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mold release agents.
2. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
3. Exposed metal surfaces used in interior areas, except chromium plated parts, shall be given an even coat of high grade methacrylate lacquer, or transparent epoxy with a satin finish.
4. All castings, extrusions, and spinnings shall be machined, sanded or similarly treated, and given minimum one coat of baked-on clear methacrylate lacquer, unless a painted finish is specified, to provide a consistent texture, color, and finish throughout all exposed surfaces.
5. Exterior metal surfaces such as extruded parts or castings which do not otherwise receive a finishing coating, shall be machined, sanded or similarly treated. All such finished components shall be given a minimum of one coat of baked-on clear methacrylate lacquer, satin finish, unless an alternate finish is specified.
6. Aluminum surfaces exposed to the weather shall receive a duronodic or polyester powder paint or clear methacrylate lacquer finish as specified for corrosion resistance. When in contact with concrete, aluminum shall be coated with bituminous paint, zinc chromate primer, or separated by a layer of plastic or other gasketing material. Creosote and tar coatings should not be used because of their acid contents.
7. For weatherproof and vaportight fixtures, painted finishes and accessories shall be weatherproof enamel using proper primers or galvanized and bonderized epoxy in accordance with the manufacturer's requirements. Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years.
8. Sheet steel fixture housings, iron and steel parts, which have not received phosphating treatment ("Bonderizing" or similar process) or are to be utilized in exterior applications shall be made corrosion resistant by zinc or cadmium plating, or hot-dip zinc galvanizing after completion of all forming, welding, or drilling operations. Where aluminum parts come in contact with steel (or other metals), the steel shall be zinc plated or cadmium plated. Minimum thickness of above protective coatings shall be:
   a. Hot galvanized zinc coating - 0.0005".
   b. Cadmium plating - 0.00015".
9. Parts operated under temperatures injurious to hot-dipped galvanizing shall be electroplated.
10. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating of Corogard No. 1706 as manufactured by Minnesota Mining & Manufacturing Company.

F. Completely form painted reflectors before application of primer and enamel color coats. Reflectors and reflector bodies for fluorescent lamp fixtures having baked-on white enamel finish, shall be made of steel of the thickness specified and given a suitable primer and white color coats properly applied to meet all applicable requirements and tests.

G. When requested by the Architect and Engineer, the Contractor shall submit a sufficient quantity of flat metal panels having the identical primer and color coats applied in the same manner as proposed for the Contract items, for subjection to any one or all of the tests listed herein by an approved independent testing laboratory. Provide panels of suitable size and drilled as necessary for a particular test procedure. The Contractor shall bear the cost of all required tests.

H. Wire leads to the receptacle or connector of any side-prong incandescent lamp or any "cool-beam" lamp utilizing a dichroic reflector shall be SF-2 (silicone rubber insulated) stranded wire (minimum No. of 18 AWG). Wire within housing shall be entirely covered with a flexible woven fiberglass sleeve.

I. All reflectors shall be finished according to the minimum requirements outlined below.

CLASS	MIN. WEIGHT OF COATING (mg/sq.in.)	SERVICE	% MINIMUM REFLECTIVITY	
MI	0.5	Normal interior service.	83	75
SI	7.5	Medium service, interior industrial, exterior when operated within glass.	82	73
SE	10.0	Exterior industrial or commercial service, exposed to atmosphere. Marine service enclosure.	78	65

J. All reflector and baffles of modified elliptical contour cross section shall have with no apparent brightness from above 40º above the nadir, and with no lamp image or any part of the lamp visible from above 40º above the nadir.

K. Cone flange shall be formed as an integral part of the cone and with an identical color and finish. Width of the flange covers all ceiling openings without light leaks or hardware visible.

L. Samples of colored aluminum finishes (black, brass, bronze, etc.) shall be submitted for approval before fabrication.

M. All glass lenses shall be heat treated (tempered) or sealed with a clear acrylic laminate layer to provide a “safety glass” rating. All lenses which require removal for relamping or normal maintenance shall be attached to the fixture housing by a minimal length of safety chain to prohibit the lens from falling and striking surrounding surfaces. Glass edges exposed during the relamping process gasketed to prevent chipping or cracking. Glass lenses shall be a minimum 0.375” thick.

N. Glass lenses specified as translucent or “opal” shall be treated as follows:

1. Sand blasted.
2. Acid etched.
3. White flashed.

O. Actual location of fixtures shall be as shown on the architectural reflected ceiling plans, or as directed by the Architect. Spaces for fixture insertion will be provided under the Division that installs the ceiling. Plaster and other frames shall be turned over to the Division for General Construction for setting and installation, under another Division of these Specifications. Contractor shall be responsible for obtaining fixtures designed to fit properly into these ceilings. The Contractor's attention is directed to the requirements of the acoustical ceiling, particularly to the need for close coordination between the ceiling construction details and lighting fixture design. The electrical contractor is responsible for coordinating mounted hardware to match ceiling type.

P. All methods of construction and details of workmanship, where not specifically described or shown on the Drawings, shall be satisfactory to the Architect and shall be subject to his approval. All joints between fixture wiring shall be made with Buchanan #2008S or equivalent solderless connectors by Thomas and Betts.

Q. All lighting fixtures on emergency generators or battery circuits shall be provided with a red dot or approved marker. Fixtures with internal batteries shall be provided with test switch and pilot light.

2.4 MATERIALS AND FABRICATION

A. Provide thickness of metal required or as specified so that all fixture are rigid, stable and will resist deflection, twisting, warping or bending under normal installation procedures, loading, relamping, etc.

B. Provide neoprene or silicone gasketing, stops, and barriers where required to prevent light leak or water and water vapor (penetration).

C. Provide finished product with ground metal edges, tight fitting connections, hinges and closures; clean, neat edges, trims, and frames; continuous welds, ground smooth with sharp corners; all exposed screws countersunk flush.

D. Provide positive, durable means of connection at all joints as required.

E. All cast parts, including die-cast members, shall be of uniform quality, free from blow holes, pores, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.

F. Provide sufficient ventilation for lamps, ballasts and transformers including vent holes where required. Outdoor fixtures shall have corrosion resistant wire mesh screens in the vent holes.

G. All adjustable fixtures shall be provided with reliable locking device to secure aiming angles of the fixture housing or lamp yoke as well as lamp and lens orientation devices to secure oval beam pattern lamps and/or spread lenses.

2.5 FINISHES

A. Fixture finishes shall be applied in a manner that will assure a durable, wear resistant surface.

1. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mold release agents.
2. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
3. Provide all ferrous metal surfaces with a protective finish having rest-inhibiting properties. Painted finishes shall be a minimum of 1.5 mils thick and shall have a balance between hardness and bending properties suitable for application. White finishes shall have 87 percent minimum reflectance. Application and cleaning shall be performed so as to prevent any loss of reflectance capability.
4. Finish shall be porcelain or baked enamel, matte white on interiors with minimum tested reflectance of 86%. Manufacturer's standard finish or as specified on plans, on visible exteriors. Base metal shall be thoroughly cleaned and given bonderizing or other approved highly adhesive prime coating. All reflectors shall be of 20 gauge sheet steel with polymerized baked white coating with a reflectance ranging form 85% to 88%.

2.6 WIRING

A. All wiring shall comply with the following:

1. All wiring devices within lighting fixtures or from the fixture to the splice with the project branch circuit wiring shall be as specified below.
2. Wiring between fluorescent lampholders and associated operating and starting equipment shall be of similar or heavier gauge than the leads furnished with the approved types of ballasts with equal or better insulating and heat resisting characteristics.
3. Wiring shall be protected with tape or tubing at all points where abrasion may occur.
4. Wiring shall be concealed within the fixture construction except where design or mounting dictates otherwise.
5. Connections of wires to terminals of lampholders and other accessories shall be made in a neat and workmanlike manner and electrically and mechanically secure with no protruding or loose strands. The number of wires extending to or from the terminals of a lampholder or other accessory shall not exceed the number which the accessory is designed to accommodate.
6. Individual fixture wiring shall be not less than #16 gauge and shall be limited to insulations with rated maximum operating temperature of 150°C or higher.
7. Where branch circuit wiring calls for two-level lighting, three-and- four-lamp fixtures shall be circuited in a manner so that outer lamps can be switched separately from inner lamp(s), unless otherwise indicated on Drawings.

8. Joints in wiring within lighting fixtures and connections of the fixture wiring to the wiring of the building shall be specified in Division 26.
9. Wiring channels and wireways shall be free from projections and rough or sharp edges throughout, and all points or edges over which conductors must pass and may be subject to injury or wear shall be rounded and bushed.
10. Insulated bushings shall be installed at points of entrance and exit of flexible wiring.
11. Junction boxes attached to lighting fixtures shall be manufactured in accordance with the National Electrical Code and approved for the number of conductors indicated on the drawings. Supplementary junction boxes shall be installed where required to comply with Code.
12. When exposed, all junction boxes and conduit to be painted as per the Architects' direction at no additional cost to the Owner.
13. Cord types shall be suitable for application and be fitted with proper strain relief and watertight entries where required by application.
14. Furnish code approved wiring in ceiling cavities forming air plenums.

2.7 MARKING OF FIXTURES

A. Fixtures designed for voltages other than 110-125 volts shall be marked with operating voltage.

B. Fixtures equipped for operation of rapid start lamps shall be clearly marked "USE RAPID START LAMPS ONLY."

C. Fixtures designed for operation of lamps below the rated enclosure maximum shall be clearly marked "Lamp Watts Not to Exceed _____" to maintain the design energy load.

D. Where catalog numbers are listed, they shall be considered only as a guide. Contractor is cautioned to take care that where fixtures are ordered by catalog numbers these fixtures must incorporate all the general and particular requirements mentioned in the specification, even though it may be necessary to modify the manufacturer's standard fixture corresponding to the designated type or catalog number.

2.8 SOUND TRANSMISSION

Sound transmission through the light fixture units, when spaced as indicated on drawings, shall be sufficiently attenuated to maintain speech privacy between adjoining spaces. Contractor to provide insulating battens around the fixtures where voice and sound transmission levels are unacceptable.

2.9 THERMAL PROTECTORS

A. Provide thermal protectors as required by the N.E.C., or as required by local Code, to prevent operation of lighting fixtures in enclosed spaces or adjacent to combustible materials at temperatures at or above 90ºC (194ºF).

B. Fixtures approved for operation in fire-resistant material at temperatures up to 150ºC (302ºF) shall be plainly marked.

C. All incandescent fixtures shall be provided with thermal protectors except where otherwise indicated or where approved for operation without such protectors by the N.E.C. and by the local building authority.

2.10 LAMPS

A. Provide lamps as shown in the fixture schedule or as modified in reviewed shop drawings.

B. Lamps as specified for the individual luminaries or lighting equipment shall be delivered and installed in fixtures and lighting equipment leaving these completely lamped and in normal operating condition.

C. Hot cathode fluorescent lamps, unless otherwise designated, shall be of the rapid start type and deliver not less than 2,900 initial lumens for straight lamps. Fluorescent lamps are triphosphor, color temperature 3500˚K, with a color rendering index of not less than 85, unless noted otherwise. Refer to light fixture schedule for details.

D. Provide all incandescent lamps inside frosted, unless noted otherwise. Refer to light fixture schedule for details.

E. High intensity discharge lamps, unless noted otherwise, shall be color corrected, phosphor coated, mogul base metal halide lamps. The mogul base color rendering index (CRI) shall not be less than 80 and a color shift not exceeding ± 400ºK, unless otherwise specified. All medium base metal halide lamps to have a CRI of not less than 80 and color shift not exceeding ± 200ºK. Refer to light fixture schedule for details.

F. LED lamp sources shall conform with the IESNA LM-79 and LM-80 published standards. They shall have a color temperature binning that does not exceed +/-200K. LED Lamp life shall be rated at 70% of initial lumens remaining. LED drivers shall be used @ 100% output for lumen output rating and not be underdriven or overdriven.

G. A complete set of new lamps shall be installed in each fixture at the completion of the work. Fluorescent lamps shall be of the energy savings type, cool white or warm white, unless otherwise noted in Schedule, or directed. All fluorescent lamps shall be T-8, 1" dia., SP35, 3500°K unless otherwise noted.

H. Lamps shall be by the same manufacturer and produced by the following acceptable manufacturers:

1. General Electric Lighting
2. Osram Sylvania, Inc.
3. North American Philips Lighting
4. Venture Lighting International, Inc.
5. Others only where specified.

I. LED Lamps

1. All LED light fixtures shall conform with the IESNA LM-79 and LM-80 published standards.
2. Initial delivered lumens – thermal losses should be less than 10% when operated at a steady state at an average ambient operating temperature of 25°C, and optical losses should be less than 15%.
3. Average Delivered Lumens – Average delivered lumens over 50,000 hours should be minimum of 85% of initial delivered lumens.
4. LED boards, drivers and associated components shall have a Warranty of 5 years on the LEDs, 5 years on the driver, 10 years on the paint finish.
5. Driver Specification shall include:
    a. Electronic
        Voltage range of (120-277) +/- 10%
        1) Current .35 Add (+/- 5%)
        2) Frequency 50/60 Hz
        3) Power Factor >90% at full load
        4) THD <20% at full load
        5) Load regulation: +/- 1% from no load to full load
        6) Output ripple <10%
        7) Output should be isolated
        8) Case temperature: rated for -40º through +80 º
        9) Overheat protection, self-limited short circuit protection and overload protected
        10) Primary fused
        11) Life rating not less than 50,000 hours

2.11 LAMPHOLDERS

A. Lamp sockets shall be rigidly attached to fixture enclosure or husk.

B. Incandescent and high intensity discharge lamp sockets shall be made of heavy duty heat-resistant porcelain.

C. Plastic or metal sheet sockets are not to be used.

D. Fluorescent lamp sockets operated with an open circuit voltage in excess of 300 volts shall be of the safety type, and open the supply circuit when the lamp is removed from the sockets.

E. Provide nickel plated brass or nickel and silver plated contacts in all lampholders for tungsten halogen lamps, lamps in outdoor fixtures, and mogul base incandescent, metal halide or mercury vapor lamps.

F. All lamp sockets shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. All adjustable sockets shall be preset at the factory for lamp specified.

2.12 FLUORESCENT AND HIGH INTENSITY DISCHARGE LAMP BALLASTS

A. All fluorescent and high intensity discharge lamp ballasts shall conform to the following:

1. All ballasts for a particular lamp type shall be of the same manufacturer and where possible all ballasts on the projects be of the same manufacturer.
2. All ballasts shall be “Class P” indicating approved integral ballast protection. Fuses in the primary leads shall be provided in addition to the “Class P” ballast.
3. All ballasts shall be of the electronic high power factor type, energy saving, “super low heat” as manufactured by Universal, Motorola or approved equal.
4. All fluorescent ballasts shall be electronic, capable of maintaining a constant light output on all rapid start fluorescent lamps over operating range of 90V to 145V (120V ballast) and 200V to 320V (277 ballast). The total harmonic distortion (THD) of the ballast shall be less than 10 percent of the full light output current level. The ballast shall have a sequenced start progression which first heats cathode filaments and then ignites the lamp. The ballast shall withstand line transients as defined in ANSI/IEEE C62.41, category A; crest factor less than 1.4; power factor greater than 95% and operating frequency of 20KHZ or greater without a visible flicker. The case temperature shall not exceed 25ºC temperature rise over 40ºC ambient. Ballasts shall comply with FCC regulations Part 18, Class A.
5. All HID ballasts to be encapsulated and have maximum crest factor 1.6.
6. All HID ballasts shall meet U.L. standards for “Class H” operations (180ºC).
7. U.L. and ANSI specifications with labels and/or symbols of approval by the U.L. and of certification by the Certified Ballast Manufacturers (C.B.M.) as tested by the E.T.L.
8. The component parts shall be designed, fabricated, and assembled in accordance with the latest requirements of the N.E.C.
9. Ballasts shall provide safe and reliable operation of the specified lamps.
10. Whenever possible, provide two-lamp ballasts for fixtures with two fluorescent lamps or multiples of two lamps.
11. Approved Lamp/Ballast combinations should be used to allow for maximum energy efficiency, unless otherwise specified,
12. Identical ballasts shall be installed within each fixture type.
13. For HID fixtures specified with remote ballasts, the contractor shall verify and coordinate the maximum distance from lamp to ballast allowed.
14. Fixture design, fabrication, and assembly shall be such as to prevent overheating or cycling of lamps and ballasts under normal operating temperature variations.

15. Provide the lowest sound rating available for the lamps specified and clearly show their respective sound ratings. Ballasts found by the Architect or Engineer to be unduly noisy shall be replaced without charge prior to acceptance of the work.
16. Dimming ballasts shall be provided where dimming controls are required per the drawings, notes and schedules. Dimmer type ballasts shall be of a design recognized and approved under the U.L. component program. These ballasts must coordinate with the dimming control devices specified for the particular application. Unless specified in the Lighting Fixture Schedule, all dimming ballasts shall dim to 10%.
17. Ballasts intended for outdoor use shall have a minimum lamp starting temperature of 0ºF, except as noted otherwise.
18. Where ballasts are remote from fixture housing, provide suitable enclosure for installation with the conduit and wire from the ballast to the lamp socket clearly marked “Caution,” “High Voltage.” All remote ballasts to be installed within the recommended distance from the lamp socket as per the manufacturer with access plates for maintenance and on neoprene pads for sound absorption.
19. All ballasts shall be high power factor (over 95%) of the "Watt Reducer" type and shall have ETL-CBM certification. All ballasts shall be sound-rated and shall have manufacturer's lowest sound level rating. Ballasts shall be 120V or 277 volt 60 Hz, depending on the voltage applied in individual branch circuiting. The ordering of fixtures with the appropriate ballast voltage shall remain the Contractor's responsibility.
20. At conclusion of the work, deliver to Owner a written certificate guaranteeing all fluorescent and HID lamp ballasts for a full two years after job acceptance date. Guarantee shall also cover the cost of replacing the defective ballast and installing new ballast, as well as the purchase cost of the ballast.
21. Ballast for T5 HO lamps or smaller shall have end of live sensing circuits.
22. All fixtures controlled by occupancy sensors shall be provided with program start ballasts.
23. Provide internal disconnecting means for ballast maintenance. Disconnecting means shall disconnect all conductors, including grounded conductor.
24. Contractor to coordinate ballast line side voltage with branch circuit voltage as shown on Contract Drawings.
25. Provide multitap ballasts (Mvolt) whenever offered by manufacturer.

B. Ballasts manufactured by the following are acceptable:

1. Motorola/GE
2. Advance
3. Universal
4. Osram Sylvaria
5. Lutron (for dimming ballasts)
6. Approved Equal

C. Contractor to coordinate ballast line side voltage with branch circuit voltage as shown on Contract Drawings.

2.13 TRANSFORMERS (COLD CATHODE, NEON)

A. All transformers shall be sized to accommodate the intended load and utilized to operate lamps in a method approved by Underwriter’s Laboratory and acceptable by code and shall not exceed the following:

1. Neon: 9,000 volts, 30 ma.
2. Cold Cathode: 150 ma.

B. Transformers for non-dimming installations shall be high power factor type, voltage as specified in LIGHTING FIXTURE SCHEDULE. Transformers for dimming installations shall be 120 Volt, 60 hertz, low (normal) power factor type. Fixture manufacturer shall confirm compatibility of transformer with dimming system manufacturer. Secondary voltage shall be as required by lamp footage, cold weather usage and dimming. Transformers shall be UL listed, self-contained steel enclosure equipped with a disconnect switch which shall automatically disconnect the primary when the wiring compartment cover is removed. Transformers shall be installed in accessible and ventilated area (100°F maximum ambient temperature) with air circulation on all sides to dissipate full wattage rating of the transformer. Each transformer shall be installed as close to the lamp as possible in order to keep the secondary

feeds as short and equal in length as possible. Wiring compartments shall be accessible if mounted above ceilings, in partitions, or in any location other than electrical closets.

C. Provide self contained, U.L. listed transformers in 16 gauge steel housing with secondary and primary wiring compartments, mount all transformers securely to the fixture housings (if integral) or to the building structure (if remote) with neoprene pads to isolate vibration and noise.

D. Provide all transformers with secondary overcurrent protection and a primary disconnect switch, which will automatically disconnect the primary switch when the wiring compartment cover is removed.

E. All transformers shall be installed in an accessible and ventilated location with a maximum 100ºF, ambient temperature with air circulation on all sides.

F. All winding type transformers will be high power with a maximum crest factor of 1.6.

G. All regulating transformers shall be tested to have an output regulated to +/-3 percent for input variations of 15 percent to 25 percent, less than 3 percent distortion with a minimum load efficiency of 85 percent, and operating temperature of -20ºC to 70ºC.

2.14 REFLECTORS

A. All reflectors shall be of glass or metal of the type required by the drawings and of the size recommended by the manufacturer for the lamp rating indicated. In all cases, holders shall be made so as to support the reflector in proper relation to the lamp filament

B. Reflectors and reflecting cones or baffles shall be as follows:

1. Absolutely free of any tooling marks including spinning lines, indentations caused by riveting or other assembly techniques.
2. No rivets, springs, or other hardware visible after installation.
3. First quality polished, buffed and anodized finish, “Alzak” or approved equal.
4. Specular finish color as selected by the Architect or as specified in the fixture schedule.

C. Other aluminum reflectors shall be as follows:

1. Formed and finished as noted on the Drawings and elsewhere in the Specification.
2. Reflectors free from blemishes, scratches, or indentations which would distort their reflective function.
3. Finished by means of the “Alzak” process or approved equal unless otherwise noted.

D. Reflector and housing shall comply completely enclose the fixture’s fluorescent lamp in downlights in a plenum ceiling and provide the full rated output of the lamp. Fixtures that vent through the downlight reflector into the plenum are not acceptable.

2.15 LENSES AND DIFFUSERS

A. All lenses secured by positive means with neoprene or silicone gasketing or washers as required to hold the lens tight within a frame or attach to a housing.

B. All glass lenses shall be heat treated (tempered) or sealed with a clear acrylic laminate layer to provide a “safety glass” rating. All lenses which require removal for relamping or normal maintenance shall be attached to the fixture housing by a minimal length of safety chain to prohibit the lens from falling and striking surrounding surfaces.

C. Acrylic lenses shall be 100 percent virgin acrylic polymer and colorless and shall be guaranteed for 15 years against crazing or warping. Lens shall be (.156”) thick.

D. The quality of the raw acrylic material must exceed IES, SPI, and NEMA Specifications by at least 100 percent which, as a minimum standard, shall not exceed yellowness factor of 3 after 2,000 hours of exposure in the Fade-o-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

E. All plastic diffusers shall be given an approved destaticizing treatment prior to installation, and instructions shall be left with Owner for similar destaticizing after cleaning. Diffusers must be put up with no finger or dirt-marks. Use white gloves, if necessary.

2.16 LOUVERS

A. All louvers shall be fabricated of the specified material.

B. All fluorescent light fixture louvers shall be parabolic and shall be rated at 90 percent or over on the VCP index.

C. Louver finishes shall be provided as specified.

D. All plastic parabolic louvers shall be destaticized before and after fabrication to insure minimum maintenance.

E. All metal louvers shall be coated with anti-rust material and electrostatically painted.

F. All louvers shall be heat tested to withstand lamp operating temperatures with no deformation of shape, paint blistering or discoloration.

2.17 FIXTURE TRIMS

A. Fixtures shall have finish trim designed for the following types of ceiling systems: Ceiling Type Trim Type

1. Recessed Incandescent, Fluorescent, or Metal Halide Fixtures
    a. Plaster - Overlap Trim.
    b. Concrete - Overlap Trim.
    c. Tile - Overlap Trim.
    d. Gypsum - Overlap Trim.
    e. Metal Pan, Concealed M - Modular, Fit-in Support.
    f. Lay-in - Modular, Tile with Flush Fit-in.

B. Provide trim details as shown on the Drawings or as specified, which are indicative of appearance and dimensional requirements. The trim finish and dimensions subject to the approval of the Architect.

C. Trimless fixtures shall be installed per manufacturer's guidelines and shall be installed and coordinated with other trades as required.

D. Mitered corners shall be continuously welded and smoothed before shop finish is applied. No lapping of trim metal for all flush mounted ceiling trims for rectangular or square recessed fixtures.

E. Provide a mounting frame or ring with lock recessed or semi-recessed light fixture to secure the mounting frame to the ceiling and support any reflectors, trims, or lenses. Ring shall be compatible with the ceiling and of sufficient strength to rigidly support the fixture and any stress applied in relamping.

F. Catalog numbers are included for reference. Provide all accessories and design features described herein regardless of whether such features are included in catalog reference including, mounting hardware, louvers, lenses, filters, transformers, etc.

2.18 LIGHTING FIXTURE TYPES AND CATALOG NUMBERS

A. General: Various fixtures types required are indicated on drawings fixture schedule. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify ceiling types, modules, suspension systems appropriate to installation.

2.19 SUPPORTS FOR SUSPENDED FIXTURES

A. Provide separate and isolated suspension for all fixtures required by the Local Building Department and seismic requirements. This may include rod hangers, hook hangers, or single stem hangers.

2.20 EMERGENCY LIGHTING UNITS

A. Provide 90-minute battery pack emergency lighting fixtures with two lamp heads for all mechanical equipment rooms, electrical equipment room, generator area, etc. Battery units shall be self-contained, self diagnostic, sealed, maintenance free, lead-acid type with 10-year normal life warranty.

B. Provide in sufficient quantity that light produced by these emergency fixtures shall provide one foot-candle maintained throughout the space have chargers and wire guards.

C. Where battery back-up is required for linear LED or fluorescent sources, provide 1400 lumen output battery packs, for a 4ft. lamp length and equivalent efficiency on shorter lamp lengths and compact fluorescent. Operation shall be for a continuous 90 minutes. Provide battery unit with automatic switching to battery upon loss of power to sensing circuit. Battery unit shall be designed and connected such that the lighting fixtures with these battery units can be switched off while maintaining automatic battery function when sensing circuit looses power.

D. All metal halide fixtures connected to an emergency circuit shall have a quartz restrike and a time delay relay to illuminate the space for emergency purposes. Quartz lamps shall remain on until 50% of metal halide lamp output is achieved. Quartz wattage shall be equivalent to the metal halide lamp.

E. All Exit signs shall be provided with 90 minute battery backup, and come complete with mounting hardware directional chevrons, mirrored backing and graphics. Single face exit signs shall be constructed to they can read from either side.

F. Exit signs shall be edge-lit with faces and directional arrows per plans.

G. All single-face edge-lit exit lights shall have a mirrored backing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF LIGHTING FIXTURES

A. Contractor to coordinate exact quantities and critical dimension with field conditions.

B. Contractor to verify and coordinate that appropriate framing, support structures, mounting brackets, and other required structural connections are provided by the General Contractor or other trades to insure a timely, neat installation of all luminaries.

C. Contractor to coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances to effectively install the luminaries. Provide each light fixture with complete installation instructions. All light fixtures to be installed in strict conformance with manufacturer's recommendations and instructions.

D. Coordinate space conditions with other trades.

E. In Mechanical Equipment Room modify locations and mounting to suit conditions as directed. Electrical contractor must coordinate fixture location with mechanical equipment room layout or wait until mechanical equipment is installed

F. Install lighting fixtures in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

G. Exact locations of all lighting fixtures including mounting heights and plan dimensions are as per the Architectural Drawings. Any ambiguities or conflicts in this dimensional information to be identified to the Architect prior to installation.

H. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than specified herein, for review by Architect.

I. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.

J. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

K. Fasten fixtures securely to structural supports, and ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum on inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.

L. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified on UL Stds. 486A and 486B and the National Electrical Code.

M. Support pendant mounted fixtures greater than an overall 2 feet in length at a point in addition to the outlet box fixtures stud with an appropriate safety cable. Certain decorative pendant fixtures may not require a safety cable, verify with Architect, Engineer or Lighting Designer.

N. Fasten electrical lighting fixtures and brackets securely to indicate structural supports, including poles/standards, and ensure that installed fixtures are plum and level.

O. Rigidly align all continuous rows of fixtures for true in-line appearance.

P. Do not install exposed fixtures, reflectors or trims until all plastering and painting that may mar fixture finish is completed. Replace blemished, dented, damaged or unsatisfactory fixtures as directed.

Q. Support all fixtures independent of ductwork or piping.

R. Install rows of fixtures in straight lines, except as noted. Install fixtures so that fixture doors open from same side.

S. Pendant mount fixtures where indicated nd provide all mounting hardware.

T. Mount fixtures in accordance with manufacturer's installation details and applicable codes. Provide all required accessories.

U. Install reflector cones, baffles, aperture plates, and decorative elements after completion of ceiling tiles, painting and general clean-up.

3.3 FIELD QUALITY CONTROL

A. Replace defective and burned out lamps for 3 months following the Date of Substantial Completion.

B. At Date of Substantial Completion, replace lamps in lighting fixtures which have been operational over 400 hours and have a lamp life of less than 4,000 hours.

1. Refer to Division-1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.

C. Furnish stock or replacement lamps amounting to 5%, but not less than 4 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner’s storage space.

D. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

E. Certify that the equipment has been properly installed, adjusted, and tested.

F. For sloped ceilings:

1. Provide sloped ceiling adapters for all fixtures in sloped ceilings.

2. Contractor shall coordinate with architectural details for degrees of slopes, mounting details, etc.

3.4 AIMING AND ADJUSTMENT

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under observation of the Architect and Engineer. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc., required shall be furnished by the Contractor. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely. The aiming and adjustment of luminaires must take place after the projects amenities have been completely installed. These amenities shall include but are not limited to plantings, furniture, artwork, graphics and signage.

B. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing, aiming shall be accomplished at night.

C. Provide positive locking devices to preclude mis-focus during relamping.

3.5 CLEANUP

A. Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses. Two weeks prior to substantial completion, re-clean all fixtures for dust, fingerprints, smudges from all visible parts of the fixture.

B. Protect installed fixtures from damage during remainder of construction period.

C. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and al lamps shall be operative.

3.6 GROUNDING

A. Provide equipment grounding connections for lighting fixtures as indicated by branch circuitry. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.7 DEMONSTRATION

A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 26 51 01

OCCUPANT SENSORS AND INSTALLATION COMPONENTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. This Section is coordinated with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 23 05 01 - Mechanical and Electrical Coordination shall apply.

1.2 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all vacancy sensors in accordance with drawings and specifications.

1.3 QUALITY ASSURANCE

A. "Manufacturers" - Firms regularly engaged in manufacture of vacancy sensors and installation components, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Provide vacancy sensors and installation components produced by a manufacturer listed as an Approved Manufacturer in this Section.

C. Provide equipment whose performance under specified conditions is certified by the manufacturer.

D. All equipment shall be U.L. listed.

1.4 SUBMITTALS

A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination shall apply and submit shop drawings. Shop drawings shall include vacancy sensors, control units, relays, etc.

1.5 GUARANTEE

A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Ceiling and Wall Dual Technology Sensors

1. Sensors shall be ceiling or wall mounted as indicated on plans.
2. Sensor shall have a microprocessor and utilize adaptive technology to optimize the sensor behavior to fit occupant usage patterns and adjust sensitivity and time delay to changing conditions.
3. Sensor shall not require any manual adjustment at the time of installation or during operation.
4. Sensor shall adapt automatically to changing room conditions.

5. Sensor shall utilize either passive infrared and ultrasonic technology to detect motion. Sensor shall not react to noise or ambient sound.
6. The sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
7. Sensor's microprocessor shall monitor PIR background levels and automatically make corresponding adjustments.
8. Sensor shall incorporate a dual element pyrometer and 12-element cylindrical Fresnel lens.
9. Sensor shall be provided with a variety of masking inserts for PIR rejection to prevent false tripping.
10. Sensor's microprocessor shall monitor ultrasonic frequency changes and automatically make corresponding adjustments.
11. Sensor's microprocessor shall automatically adapt to a continuous airflow situation.
12. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
13. Sensor shall have an ultrasonic frequency of 32kHz or 40kHz.
14. Sensor coverage shall range from 0 to 2000 sq. ft. depending on model.
15. Sensor shall be available with either a 110 degree, 180 degree, or 360 degree field of view, as specified on drawing.
16. Sensor shall recognize, as a false on, the failure to detect motion 6 seconds after motion is detected initially (turning on the lighting). The sensor shall decrease the sensitivity in response to the false on.
17. Sensor shall feature an 8-second time out install test mode, which will automatically revert to standard time out one hour after being put into test mode.
18. Sensor shall have manual controls and override switches to force manual adjustments.
19. Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.
20. Sensor shall have timer that can be adjusted manually from 8 to 30 minutes.
21. Sensor sensitivity shall be adjustable from 0% to 100%
22. Sensor shall have a control knob that sets the minimum setting for the timer in automatic mode.
23. Sensor shall have control knobs for setting the initial automatic sensitivity adjustments.
24. Sensor shall have a switch to restore factory settings.
25. Sensor shall have real time motion indicator LED's visible from the front of the unit. Red = Infrared, Green = Ultrasonic.
26. Sensor shall operate at universal voltages 100 - 277VAC; 50/60Hz, with each relay able to operate on a different voltage.
27. Sensor shall accept Class 2 wiring.
28. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
29. Sensor shall be ETL listed (Conforms to UL STD 508 Certified to CAN/CSA STD C22.2 NO.14).
30. Sensor shall have a standard 5-year warranty.
31. Sensor shall be available in White.
32. Sensors located within Inn Guestrooms shall be battery powered.

B. Wall Switch, Dual Technology Vacancy Sensor

1. Sensor shall be two self-contained, dual technology motion sensing type. Unit can be mounted to any standard single or two gang outlet box.
2. Sensors shall require manual turn on and automatic and manual turn off.
3. Sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
4. Sensor shall not react to acoustic noise or ambient sound.
5. Sensor shall adapt automatically to changing room conditions.
6. Sensor's microprocessor shall monitor PIR background levels and/or ultrasonic frequency changes and automatically make corresponding adjustments.
7. Sensors utilizing passive infrared detection technology shall incorporate a dual element pyrometer and 12-element cylindrical impact resistant Fresnel lens.

8. Sensors utilizing ultrasonic detection technology shall have an ultrasonic frequency of 32 to 40 kHz.
9. Sensor shall operate at universal voltages 100 - 277VAC; 50/60Hz, with each relay able to operate on a different voltage.
10. Sensor shall have no minimum load requirement and shall be capable of switching 0 to 1000W Ballast or 1/6HP @ 100/120VAC, 50/60 Hz; 0 to 1800W Ballast or 1/6 HP @ 230/277VAC, 50/60 Hz.
11. Sensor shall have line and load control wires plus a ground wire for safety. Sensor shall not require a neutral.
12. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.
13. Sensor shall have a user accessible ON/OFF control for each circuit.
14. When the sensor is in the 5-sec test time out mode, depressing the push button reverts the unit to standard time out mode.
15. Sensor shall retain all learned adjustments and programmed modes of operation even after power loss.
16. Sensor shall close the relay at zero crossing to protect the contacts.
17. Sensor shall recognize the lighting turning off exactly 1 timeout period as a false on. In response to the second false on, sensitivity settings are automatically adjusted accordingly.
18. Sensor shall automatically determine and calibrate the ambient light level set point (10 -500 fc) when put into daylight mode.
19. Sensor shall have a mode which turns lights off during periods of vacancy if ambient light levels increase sufficiently to illuminate the area.
20. Sensor shall have a hallway algorithm, that when enabled reduces false tripping of the lights associated with hallway traffic outside the room where the sensor is controlling the lights.
21. Sensor shall have an adaptive reset switch, that when enabled resets the sensor's adaptive timer and sensitivity settings.
22. Sensor shall have configuration switches that are only accessible with fascia cover removed.
23. Sensor shall have a safety air gap disconnect switch.
24. Sensor shall have an automatic timer mode of 4-30 minutes which self adjusts based on vacancy.
25. Sensor shall have a fixed timer mode of 4, 8, 15 and 30 minutes.
26. Sensor shall have a 5-sec time out test mode, which reverts to standard timeout after pressing any button or automatically after one hour.
27. Sensor shall have a minimum 4-min time out (standard).
28. Sensor shall feature a walk-through mode, where lights turn off three minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.
29. To avoid false on activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
30. Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 degree.
31. Each sensing technology shall have a LED indicator that remains active at all times in order to verify detection within the area to be controlled.
32. Sensor shall be able to control incandescent, magnetic low voltage, electronic low voltage, and fluorescent loads.
33. The Dual Technology wall switch sensor shall be a completely self contained control system that replaces a standard toggle switch.
34. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
35. Sensor shall have standard 5-year warranty.
36. Sensor shall be ETL listed (Conforms to UL STD 508 Certified to CAN/CSA STD C22.2 NO.14).
37. Sensors located within Inn Guestrooms shall be battery powered.

C. Power Packs and Relays
1. Power pack shall be a self-contained transformer and relay module.
2. Power pack shall have primary universal voltage inputs of 100-277VAC, 50/60Hz.
3. Power pack shall have dry contacts capable of switching 20 amp ballast and incandescent load @ 120 VAC, 60Hz; 20 amp ballast @ 277 VAC, 60Hz; 1HP @ 120-277 VAC, 60Hz.
4. Power pack shall provide a 24 VDC, 150mA output.

5. Power pack shall provide overload protection. A momentary or continuous short of any of the control wires will not damage the device.
6. Power pack shall provide Zero Arc Point Switching to protect from the effects of inrush current and increase product life.
7. Power pack shall be capable of parallel wiring without regard to AC phases on primary.
8. Power pack can be used as a stand alone, low voltage switch, or can be wired to sensor for auto control.
9. Power and auxiliary relay packs shall be suitable for use in plenum applications.
10. For ease and speed of installation, power and auxiliary relay pack shall have 1/2" snap-in nipple for 1/2" knockouts and shall mount on the outside or inside of enclosure.
11. Power and auxiliary relay packs shall have a 5 year warranty.
12. Power and auxiliary relay packs shall be UL and CUL listed.
13. Power and auxiliary relay packs controlling emergency circuits shall be UL 924 listed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine locations where wiring devices and installation components are to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install vacancy sensors and installation components where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that installation complies with requirements and serves intended purposes.

1. Locate switches near doors at the strike side of doors as finally hung.
2. Install devices only after wiring is completed.

B. Provide tape masking of sensors as required to prevent unintentional sensor activation by walking past an office with an open door.

C. Set dip switches on all sensors as specified.

D. Coordinate with other work as necessary to interface installation of vacancy sensors and installation components.

E. Installation shall comply with the requirements of NEC and NECA, "Standard of Installation".

F. At time of completion, replace items which have been damaged.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of vacancy sensors and installation components, and after connection to power source, test devices and installation components to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactory corrected.

B. Test devices and installation components to ensure electrical continuity of grounding connections.

END OF SECTION

DIVISION 27
COMMUNICATIONS

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. All work of Section 270526 - Grounding and Bonding for Communications Systems
2. All work of Section 270529 – Hangers and Supports for Communications Systems
3. All work of Section 270536 – Cable Trays for Communications System
4. All work of Section 270553 - Identification for Communications Systems
5. All work of Section 270800 - Commissioning of Communications
6. All work of Section 271116 - Communications Cabinets, Racks Frames and Enclosures
7. All work of Section 271119 - Communications Termination Blocks and Patch Panels
8. All work of Section 271123 - Communications Cable Management and Ladder Rack
9. All work of Section 271313 - Communication Copper Backbone Cabling
10. All work of Section 271323 - Communication Optical Fiber Backbone Cabling
11. All work of Section 271323.13 - Communications Optical Fiber Splicing and Terminations
12. All work of Section 271513 - Communications Copper Horizontal Cabling
13. All work of Section 271543 - Communications Faceplates and Connectors
14. All work of Section 271619 – Communications Patch Cords, Station Cords & X-Connects

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Not Applicable

1.3 SPECIAL CONDITIONS

A. The general conditions for contracts of construction, referred to in the contract documents as the General Conditions, together with the following articles of the Communications Structured Cabling Specifications, which amend, modify and supplement various articles and provisions of the General Conditions, are made part of the Contract and shall apply to all work under the Contract.

B. The Contractor represents that he/she is familiar with, and has expertise in the Work of this nature and scope. The Contractor further agrees that he/she shall provide all Work as may be required to make a complete job of that which may not be fully defined in the Contract documents.

C. These specifications are material, equipment, and performance specifications. Actual installation requirements shall be as indicated on the TN-series drawings. Installation details indicated on the drawings shall govern if they differ from the specifications. Contractor is obligated to identify such differences at the time of bid submission.

D. Contractor shall comply with all applicable governmental regulations and with all Federal, State, City, and other applicable codes and ordinances. If the contractor performs any work which is contrary to such regulations, codes, and ordinances, contractor shall make all changes to comply therewith and bear all costs arising there from.

E. It is the intent of this Specification that all items under these Sections be engineered, assembled, installed and maintained by, and under the full responsibility of a single Contractor, whether these processes are actually performed by the Contractor or not. Deviations from this intent are to be fully described in the proposal, with reasons for the same, and the coordination methods required facilitating the least effect of the deviation on the project's implementation.

1.4 WORK INCLUDED

A. The Owner seeks to identify a qualified telecommunications cabling contractor capable of performing the scope of work as identified in the Contract Documents.

B. It is the intent of these Specifications to create an ANSI/TIA-942-A compliant cabling system to support high-speed data applications up to 100 Gbps including IEEE standards based on 1G, 10G, 40G, and 100 Gigabit Ethernet. System acceptance shall be judged on its ability to perform as such, the successful adherence to the installation instructions of this Specification, and compliance with parts and workmanship warranties.

C. The work covered by this specification includes the installation of a complete cabling system, including all labor necessary to perform and complete such installation, all materials and equipment incorporated or to be incorporated in such installation, and all services, supervision, consumable items, fees, licenses, facilities, tools, and equipment necessary or used to perform and complete such installation.

D. The Work Included is defined by the following and further defined in the drawings and Sections of Division 270500.

1. Provide project management and oversight for the installation of a complete structured cabling system.
2. Prepare and submit component documentation shop drawings, outlet labeling drawings, cable pull/termination schedules, cable test results and as-built drawings as described within this Specification and per the General Conditions.
3. Preparation of shop drawings, record or as-built drawings, manufacturer cut sheets, and other documentation described herein.

1.5 REFERENCES

A. Abbreviations and Acronyms

1.	A/E:	Architect / Engineer (designer)
2.	ANSI:	American National Standards Institute
3.	AHJ:	Authority Having Jurisdiction
4.	APC:	Angled Polished Connector
5.	BDF:	Building Distribution Frame
6.	BICSI:	Building Industry Consulting Service International

7.	CMP:	Communications Plenum cable
8.	CMR:	Communications Riser cable
9.	DAS:	Distributed Antenna System
10.	ELFEXT:	Equal Level Far End Cross Talk
11.	ER:	Equipment Room
12.	F/UTP:	Foil Screened Unshielded Twisted Pair
13.	FOTP:	Fiber Optic Test Procedure
14.	GHz:	Gigahertz
15.	IDC:	Insulation Displacement Conductor
16.	IDF:	Intermediate Distribution Frame
17.	IT:	Information Technology
18.	ISP:	Inside Plant
19.	LC:	A type of small form factor optical fiber connector
20.	LOMMF:	Laser Optimized Multimode Fiber
21.	MDF:	Main Distribution Frame
22.	MHz:	Megahertz
23.	MMF:	Multimode Fiber
24.	MPO:	Multi-fiber Push On connector
25.	MPOE:	Minimum Point of Entry
26.	NEXT:	Near End Cross Talk
27.	OFNP:	Optical Fiber nonconductive plenum cable
28.	OFNR:	Optical Fiber nonconductive riser cable
29.	OSP:	Outside Plant
30.	OTDR:	Optical Time Domain Reflectometer
31.	PoE:	Power-over-Ethernet
32.	PSELFEXT:	Power Sum Equal Level Far End Cross Talk
33.	PSNEXT:	Power Sum Near End Cross Talk
34.	RCDD:	Registered Communications Distribution Designer
35.	RMU:	Rack Mount Unit
36.	RoHS:	Restriction of Hazardous Substances
37.	ScTP:	Screened Twisted Pair
38.	STP:	Shielded Twisted Pair
39.	SMF:	Single mode Fiber
40.	TBB:	Telecommunications Bonding Backbone
41.	TCIM:	Telecommunication Cabling Installation Manual
42.	TDMM:	Telecommunications Distribution Methods Manual
43.	TDR:	Time Domain Reflectometer
44.	TGB:	Telecommunications Grounding Busbar
45.	TIA:	Telecommunications Industry Association
46.	TMGB:	Telecommunications Main Grounding Busbar
47.	TR:	Telecommunications Room
48.	TSER:	Telecommunications Service Entry Room
49.	UL:	Underwriters Laboratory
50.	UTP:	Unshielded Twisted Pair
51.	WAP:	Wireless Access Point

B. "PROVIDE" or "FURNISH" means to supply, purchase, transport, place, erect, connect, label, test and turn over to Owner, complete and ready for regular operation, all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for a telecommunications cabling system.

C. "SUPPLY" means to purchase, procure, acquire, and deliver complete with related accessories.

D. "INSTALL" means to move from property line, set in place, join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner of equipment and/or components. It means the installation is to be complete and ready for regular operation, except as otherwise noted.

E. "WIRING" or "CABLING" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.

F. "CONDUIT" and CABLE TRAY" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.

G. AS DIRECTED" means as instructed by the IT Project Manager or his representative.

H. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.

I. "EXPOSED" means not installed underground or "CONCEALED" as defined above.

J. “PERMANENT LINK” means the end-to-end test configuration for a link excluding test cords and patch cords, but including the mated connection with the link.

1.6 CODES, REGULATIONS, AND STANDARDS

A. All equipment shall be equal to or exceed the minimum requirements of OSHA, NEMA, IEEE, ASME, ANSI, NEC and Underwriters Laboratories.

B. The installation shall comply fully with all applicable local, county and state laws and ordinances, regulations and codes.

C. Local electrical and building codes in New York may be more stringent than national codes, recommendations or practice. Follow the most restrictive code or recommendations.

D. All products, services and materials provided and performed under the scope of this specification shall conform to the following codes and standards. Refer to the most recent version, update or addenda.

1. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual - latest edition
2. Building Industry Consulting Service International (BICSI) Information Transport Systems Installation Manual (ITSIM) – latest edition
3. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
5. ANSI/TIA-569-C, Telecommunications Pathways and Spaces
6. ANSI/TIA-606-B, Administration Standard for Telecommunications Infrastructure
7. ANSI/TIA-607-B, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
8. ANSI/TIA-942-A, Telecommunications Infrastructure Standard for Data Centers
9. ANSI/TIA-455-57-B, FOTP-57, Preparation and Examination of Optical Fiber End Face for Testing Purposes
10. ANSI/TIA-455-78-B FOTP-78, Measurement Methods and Test Procedures – Attenuation
11. ANSI/TIA-455-95-A FOTP-95, Absolute Optical Power Testing for Optical Fiber and Cables
12. ANSI/TIA-455-133-A FOTP-133, Measurement Methods and Test Procedures – Length Measurement
13. ANSI/TIA-492AAAC-A, Detail specification for 850 nm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers
14. ANSI/TIA-492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak
15. ANSI/TIA-526-7, OFSTP-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

16. ANSI/TIA-526-14-B, Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
17. ANSI/TIA-758-B Customer Owned Outside Plant Telecommunications Infrastructure Standard
18. FCC Part 15
19. FCC Part 68
20. IEEE 802.3-2012
21. IEEE 802.11, Wireless Ethernet Specifications, including 802.11a, 802.11b, 802.11g and 802.11n.
22. NEC Article 392.5, Construction Specifications for Tray Modification
23. NEC Article 770, Optical Fiber Cables
24. NEC Article 800, Communications Circuits
25. NFPA 70, National Electrical Code
26. NFPA 75, Protection of Electronic Computer / Data Processing Equipment

1.7 QUALITY ASSURANCE

A. All materials furnished shall be new, unused, clean and free from damage, defects or corrosion.

B. Equipment and materials of the same type shall be a product of the same manufacturer throughout unless specifically exempted in advance. A specific example is all products comprising the Permanent Link (station cable, patch panels, jacks, faceplates, etc.…)

C. Component manufacturer shall be ISO 9001:2008 and offer products that are RoHS compliant.

1.8 SUBMITTALS

A. Certificates:

1. Submit management and installation team reference documentation verifying that:
   a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.
   b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.

B. Qualification Statements

1. The contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

C. Shop Drawings

1. Refer to requirements listed in Division 01.

1.9 COORDINATION OF WORK

1. Refer to requirements listed in Division 01.

1.10 PROJECT CLOSEOUT

A. Subsequent to the installation and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in AutoCAD 2010 format, that reflect the lengths of cables installed, the actual manner and conditions

of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include all specified labeling and pathway routing detail. Pathway routing detail shall be provided in excel format for importation into Owner database. Identifiers used to label cables and components as specified in Section 270553 shall be used in identifying cables and components in record drawings.

B. Provide revised cable termination schedules for all cables installed under the Work. Format to comply with owner system requirements. Schedules shall be in printed form and on either CD, DVD, USB in Microsoft Excel format. Identifiers used to label cables as specified in Section 270553 shall be used in identifying cables in cable termination schedules.

C. Provide two (2) sets of Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals in a high quality, 3-ring binder, completely indexed. Provide manuals within fifteen days of systems acceptance

D. Provide two (2) sets of all cable test results in the native format of the test equipment vendor and in excel format on CD, DVD or USB. Identifiers used to label cables as specified in Section 270553 shall be used in identifying cables in cable test results

1.11 MANUFACTURER'S EXTENDED WARRANTIES

A. All manufacturer extended product warranties shall be afforded to The Owner. A copy of certification by the manufacturer for all products listed in this specification is to be provided.

B. Prior to commencement of the work, the successful bidder shall contact an authorized manufacturer’s representative to inform them that this job is being registered under the warranty program. Bidder shall provide an additional copy of all warranty notifications to owner.

C. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 STAFFING

A. Craft personnel shall be certified personnel qualified to perform the work and be knowledgeable of the following activities included but not limited to:

1. Color coding of standard American telephone/ data telecommunications cables.
2. Bonding and grounding of telecommunications systems
3. Testing conductors for transmission impairments.
4. Testing conductor insulation.
5. Installation and termination of optical fiber cabling.
6. Testing and verification of optical fiber transmission characteristics with a power meter.
7. Telephone and data industry cable installation standards and manufacturer's instructions will be used for in-process quality control and final acceptance of the work installation.
8. Cable tray and ladder rack installation.

B. Craft personnel will be required to provide and use the proper tools and test equipment in the performance of each activity. The tools must be in good working order, and the test equipment must have current calibration certificates, as applicable. The Owner reserves the right to review the tool and test equipment lists and maintenance procedures of the contractor.

C. Use of Site – Refer to the Division 01 Requirements.

D. Follow manufacturer's instructions for installing, connecting, and adjusting all telecommunications cabling and associated supporting, termination and splicing equipment, conduits, poke through, and cable tray. Provide a copy of such instructions at the equipment during any work on the equipment.

E. Keep all items protected before and after installation. Provide protection for exposed cables roughed onto the floor prior to their installation into the furniture systems. Clean up and remove all debris.

F. If products and materials are specified herein for a specific item or system, use those products or materials. If products and materials are not listed, use first-class products and materials, subject to acceptance of shop drawings.

G. Examine and compare the telecommunications cabling drawings and specifications with the drawings and specifications of other trades; report any discrepancies between them to the IT Project Manager; and obtain from him written instructions for changes necessary in the work.

H. The locations of structural and architectural features, sleeves, floor slots, termination and cross connect fields, panels, racks and other equipment indicated on the drawings are approximate. The contractor shall verify the existence, locations, and suitability of all such items, and shall present, with bid response, required modifications to contract documents necessary to complete this work.

3.2 SPECIAL CONDITIONS

A. Furnish, install, terminate and test all riser & tie cabling shown in the attached and associated drawings and described below.

1. The contractor shall route all copper and fiber cabling, unless otherwise identified, via overhead cable tray, ladder rack, conduits, raised floors, and poke-through unless otherwise noted
2. Cables with the same origin and destination shall take diverse paths. Diverse path is defined as paths that do not intersect and remain at least 3 feet apart along the entire route
3. All cables shall be dressed in a neat manner, observing cable bend radius limit at each rack, frame and cabinet, and on ladder racks and cable trays.
4. Overhead cabling shall follow tiered cable tray system. Utilize cable waterfall for exiting ladder rack at frames and cabinets.
5. Provide Velcro cable ties at five-foot intervals for each cable bundle.
6. Provide pedestal mount J hooks for supporting cables from under floor cable tray to cabinet or frame
7. Cables must be securely bundled, but may not display insulation/sheath damage or pair distortion from over-tightening of Velcro cable ties
8. Cabling at racks and frames must be neatly dressed and Velcro tie wrapped.
9. Fiber cabling at fiber distribution frame must be secured to frame with cable clamps.

3.3 INSTALLATION

A. General

1. Subcontractor will provide paired copper, coaxial, and optical fiber backbone and horizontal cabling as noted on Drawings and Schedules.

B. Contractor shall take all necessary precautions to assure that the maximum tensile load and minimum bend radius of all cables (fiber and copper) are not exceeded. When terminating UTP cable, the contractor must maintain pair twists up to the termination point and the cable sheath shall not be removed more than 0.5" from the termination point. Velcro tie wraps are to be hand tightened on cables to prevent crimping cable sheath. Plastic tie wraps are not to be used on lateral cables. All tie wraps need to be cut so that no edges are visible that can cause potential damage to the cable bundle. The contractor is responsible for protecting all connectorized cables from damage by other contractors at the information outlet before and after installation of the outlet faceplates

C. Termination Hardware.

1. All copper and fiber cabling will be terminated on rack and cabinet mounted patch panels. The fiber optic tie cabling shall be terminated on fiber distribution coupler panels with LC connectors. All termination hardware shall be grounded and bonded according to applicable codes, TIA standards, and Section 270526.

D. Fire Stop - Penetration Sealant: Refer to work of other sections

3.4 REPLACEMENT

A. Any fiber strand, connector, block, or module installed by the contractor, which fails to meet the loss budget or tests below the manufacturer's standards, shall be replaced at no additional cost to the Owner. The replacement cable, connector, or part shall be tested after repairs have been made to verify compliance. Only equipment that meets the installation requirements stated herein shall meet The Owner's acceptance requirements.

3.5 SOURCE MANUFACTURING AND QUALITY CONTROL

A. Cables that are supplied by the contractor, and test outside of the factory test data by a margin of 10 percent on loss, may, at The Owner's option, be deemed non-usable and returned to the manufacturer for replacement.

3.6 POST IMPLEMENTATION TESTING

A. Following the physical installation of the cabling, the contractor will conduct pre-checkout tests as described below, "Physical Inspection", prior to the formal acceptance tests with The Owner.

3.7 PHYSICAL INSPECTION

A. Prior to conducting any transmission testing, the following visual inspections will be performed:

1. Verify that all cable has been installed to full compliance with the proposal specifications.
2. Check for physical damage to the optical fiber distribution panels and termination hardware.
3. Check that all cabling is properly jacketed, installation properly labeled at both ends of the cable, innerduct and termination hardware is completed.
4. Verify that all cable bends are within the manufacturer's specified bend radius
5. Verify that all cabinets and racks (which require grounding) are properly grounded and comply with the National and Local Electrical Codes for grounding
6. Verify that the cables are properly approved and structurally supported for termination
7. Verify that the requirements of all authorities having jurisdiction have been satisfied.

END OF SECTION 27 05 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Busbar
2. Ground Conductors
3. Ground Lugs

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
2. Section 271119 – Communications Termination Blocks and Patch Panels
3. Section 271123 – Communications Cable Management and Ladder Rack

1.3 SUMMARY

A. This section includes the minimum requirements for grounding, Earthing, and bonding of equipment and cable installations installed under or referred to in Division 27 Contract Documents.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 WALL-MOUNT BUSBARS

A. Manufacturer's List:

1. Chatsworth Products
2. Or approved equivalent

B. Telecommunications Main Grounding Busbar (TMGB)

1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI/TIA – 607-B and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4) mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment

C. Telecommunications Grounding Busbar (TGB)

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI/TIA – 607-B and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4) mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.

2.2 BONDING ACCESSORIES

A. Two Mounting Hole Ground Terminal Block

1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
3. The conductors shall be held in place by two stainless steel set screws.
4. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
5. Ground terminal block shall be UL Listed as a wire connector.

B. Compression Lugs

1. Compression lugs shall be manufactured from electroplated tinned copper.
2. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbar.
3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
4. Compression lugs shall be UL Listed as wire connectors.

C. Antioxidant Joint Compound

1. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

D. Equipment Ground Jumper Kit

1. Kit includes one 610 mm L insulated ground jumper with a straight two-hole compression lug on one end and an L-shaped two-hole compression lug on the other end, two plated installation screws, an abrasive pad and a tube of antioxidant joint compound.
2. Ground conductor is an insulated green/yellow stripe #6 AWG wire
3. Lugs are made from electroplated tinned copper and have two mounting holes spaces 12 mm to 16 mm apart that accept 6 mm screws.
4. Jumper will be made with UL Listed components

E. Accessory Products:

1. Provide any accessory products related to the copper connectors required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

B. Confirm all housings including back boxes, floor boxes and poke-through provided for the telecommunications connectivity system will support the installation of project approved manufacturer components prior to purchase of the components described in this specification.

3.2 INSTALLATION

A. General Installation Practices

1. Installation and testing of the telecommunications bonding and grounding infrastructure shall follow the specifications and recommendations of ANSI/TIA-607-B Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises and ANSI/NECA/BICSI-607 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

B. Grounding Hardware

1. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.
2. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure
3. TGB: Provide TGBs as shown in the Contract Documents including the ER, MDF, IDF, TRs, POE rooms, and additional technology rooms as specified in ANSI/TIA-607-B. Directly bond each TGB to its associated TBB and to the nearest building structural steel or other permanent metallic system. Group protector, busbar bonding, and approved building grounding conductors toward the left end and leave space for equipment grounding conductors to the right end.
4. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and

straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).

5. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
6. Labeling:
   a. Label the TMGB, TGB, TBBs, and bonding conductors as specified in ANSI/TIA-606-B
   b. Label TBB(s) and bonding conductors “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

C. Wall-Mount Busbar

1. Process
   a. Conductor connections to the TMGB or TGB shall be made with 2-Hole Bolt-On Compression Lugs sized to fit the busbar and the conductors.
   b. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
   c. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

D. Cable Tray and Ladder Rack (cable runway)

1. Process:
   a. Follow manufacturer’s instructions for grounding, use wherever possible use grounding hardware and accessories from same manufacturer as cable tray and cable runway systems

E. Frames & Cabinets

1. Process:

   a. Contractor to follow frame/cabinet manufacturer’s instructions specific to grounding. Use grounding hardware and accessories from same manufacturer.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 05 26

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Non-continuous cable supports.

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270536 – Cable Trays for Communications Systems
2. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
3. Section 271123 – Communications Cable Management and Ladder Rack
4. Section 271513 – Communications Copper Horizontal Cabling

1.3 SUMMARY

A. Provides specifications for non-continuous cable support components utilized to provide pathways support to telecommunications cables traveling outside cable trays, conduits, or other continuous cable supports.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORTS

A. Manufacturer's List:

1. Erico – Caddy CableCat Support System
2. Cooper B-Line – Spring Steel Fasteners
3. Panduit – J Mod Cable Support System
4. Or Approved Equivalent

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
2. Select support system components capable of supporting the telecommunications cable quantities required for each location. Options are as follows:
   a. Support slings/cable straps
   b. Four (4) inch wide J-hook supports wide base cable support J-hooks equivalent.

C. Description:

1. Non-continuous cable supports shall be available in multiple sizes, styles and materials. Rigid supports shall be equipped with flared edges and pre-configured bend radius controls.
2. Provide drop wire supports and threaded rod assemblies in areas where structural mounting surfaces are non-functional or inaccessible.
3. Sling assemblies'/cable straps shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance UTP cables. Support slings shall have a static load limit of 100 lbs.
4. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable.
5. Select approved non-continuous cable supports suitable for specific installation environments and/or air handling (plenum) spaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 NON-CONTINUOUS CABLE SUPPORT INSTALLATION

A. Process:

1. Follow manufacturer's instructions and recommended industry standards and guidelines.
2. The installed non-continuous support system must be an independent support structure for the voice/data communication system.
3. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.

4. Contractor installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three and one half feet (3'-6").
5. Supports shall be installed at a maximum distance of 5'-0"apart.
6. Non-continuous supports shall be installed with ceiling wire or threaded rod secured to the slab above to support the telecommunications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
7. Cable must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning any re-installation work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 05 29

SECTION 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Labeling and identification products

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
2. Section 271119 – Communications Termination Blocks and Patch Panels
3. Section 271123 – Communications Cable Management & Ladder Rack
4. Section 271313 – Communications Copper Backbone/Tie Cabling
5. Section 271323 – Communications Optical Fiber Backbone/Tie Cabling

1.3 SUMMARY

A. Provides specifications information for identification of the various components of the telecommunications infrastructure and pathway system.

1.4 RELATED DOCUMENTS

A. Architectural, Mechanical, Electrical, and all Technology Drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

2.1 LABELING AND IDENTIFICATION PRODUCTS

A. Manufacturer's List:

1. Brady USA Inc.
2. Panduit Corporation
3. Rhino
4. Hubbell
5. Or approved equivalent

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular requirements for each situation.

C. Description:

1. Machine-generated, printed self-adhesive, smudge resistant labels for cables, faceplates, patch panels, and termination blocks. Labels shall be appropriately sized for cable diameter. Labels shall be appropriately colored for faceplate color contrast
2. The intention of the labeling scheme is to be ANSI/TIA-606-B compliant.
3. It is the responsibility of the contractor to acquire, understand, and utilize the owner's labeling scheme for all components of the communications system.
4. Submit sample labels for approval.
5. Labels shall have industrial adhesives that resist dirt and oil.
6. Shall have a split backing for easy removal
7. Design Make
    a. Flexible Nylon
        i. For curved surfaces (wire and cable) and rough surfaces for indoor applications flexible nylon memory resistant material shall be used.
    b. Permanent Polyester Labels
        i. For flat surfaces permanent polyester shall be used.
    c. Vinyl
        ii. For outdoor applications in direct sunlight and where color coding is required vinyl shall be used.
    d. Heat Shrink Tube
        iii. Shall be polyolefin tube with a 3:1 heat-shrink ratio
    e. Non – Adhesive labels
        iv. Shall be rigid and durable polypropylene material.
8. Labeling shall meet the visibility and durability requirements of ANSI/TIA – 606-B standard.
9. Labels shall be pre-printed or laser-printed. Hand written labels are not acceptable.
10. Labels shall have white printing area and black print. If cable jacket is white, provide cable label with printing area that is any color other than white, preferably orange or yellow – so that labels are easily distinguishable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 LABELING

A. Process:

1. The Owner-approved labeling scheme is intended to comply with the ANSI/TIA-606-B standard for labeling and administration of a cable plant. It is the responsibility of the contractor to acquire, understand, and utilize the owner's labeling scheme for all component of the Voice, Data Communications system including, but not limited to:
   a. Tie cables (both ends and on each floor of an exposed cable run, such as within an Equipment Room or MDF Room)
   b. Termination panels, blocks, trays
   c. MDF entry and exit pathways
   d. Racks, Cabinets and Equipment
   e. Telecommunication cable tray, conduit pathways, & pullboxes
   f. Telecommunications grounding & bonding system

2. Contractor to provide labels as described herein for all conduits, manholes, and pullboxes at all interconnecting points as well as conduit ends as shown on the drawings.
   a. All labels shall include 'FROM-TO' information clearly stated according to owner provided information.

3. Label each component with a machine-generated label where it is accessible for administration.
4. Provide on all termination blocks installed under this Work, machine-generated designation strips with the cable ID clearly printed and pair number, in uppercase lettering.
5. Provide on all patch panels installed under this Work, machine-generated label with the cable ID and port number clearly printed in uppercase lettering. Each panel shall have a unique identification label as well.
6. Provide on all cables installed under this work, machine-generated labels with the cable ID clearly printed, in black uppercase lettering on a permanent adhesive, white label stock, covered with a permanent water resistant sealer. Labels shall be placed on both ends of each cable at no more than 6" from the point at which the cable is broken out into individual copper pairs or strands from the connector or termination block or patch panel
7. Provide all labels in accordance with Owner's labeling standards and in accordance with the approved cable termination schedule.
8. Hand lettered label stock will not be accepted for final installation. Hand lettered stock is acceptable only for temporary labeling required during construction phases.
9. All cable IDs shall be both physically and visually accessible upon completion of the project. Label locations shall be such that all labels can be easily seen and read without disassembling cable bundles or stressing cable connections in order to gain visual access.
10. If at any time during the project, any label becomes illegible, is removed, or is found to be positioned so that it will not be easily readable when cable termination and dressing are completed, the Contractor shall immediately replace it with a duplicate preprinted label.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings required prior to acceptance by the Owner.

END OF SECTION 27 05 53

SECTION 27 08 00 - COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Copper cable test device
2. Optical fiber cable test device
3. Cable Test Results
4. As-built drawings

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Sections include the following:

1. 271119 – Communications Termination Blocks and Patch Panels
2. 271313 – Communications Copper Backbone Cabling
3. 271323 – Communications Optical Fiber Backbone Cabling
4. 271513 – Communications Copper Horizontal Cabling
5. 271543 – Communications Faceplates and Connectors
6. 271619 – Communications Patch Cords, Station Cords, and Cross Connect Wire

1.3 SUMMARY

A. Provides specifications for a certification tester used for end to end testing, certification, and documentation of all test results to confirm the installed connectivity system complies with industry standards and specific category and performance ratings.

B. Contractor to notify owner three (3) days prior to testing any cabling.

1.4 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 COPPER CABLE TEST DEVICE

A. Manufacturer's List:

1. Fluke Networks

B. Product Options

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.
2. Select analyzer to comprehensively certify each category rated connection and record results verifying compliance with TIA/EIA performance specifications to meet the category rating of the system.
3. Versiv ProjX Management System.

C. Description:

1. Must meet or exceed TIA Level IV compliant network cable-testing device certification by an independent laboratory, such as Intertek, for verification of high speed, TIA/EIA T568 compliant cables.
2. Copper test equipment must be capable of certifying Category-3, Category-5e, and Category-6A UTP or F/UTP links or channels independent of termination hardware configuration (RJ45 port or 110-style) for each level of performance.
3. Provide full 2-way Auto test of Category-3, 5e, 6 and 6A twisted pair links.
4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

D. Accessory Products:

1. Interface Adapters

a. TIA Category-3, 5e, 6 and 6A: 100 ohm
b. Category/Class E permanent link adapters for TIA Cat 3, 5e, 6 and 6A unshielded and shielded cables.
c. Fluke Networks DTX ten (10) Gigabit Kit - DTX 10 Gig over Copper Test solution, Model No. DTX-10GKIT or approved equivalent.

2.2 OPTICAL FIBER CABLE TEST DEVICE

A. Manufacturer List:

1. Fluke Networks

B. Product Options:

1. Select analyzer to comprehensively certify each optical fiber connection and record results verifying compliance with TIA/EIA performance standards and manufacturer specifications.
   a. Versiv ProjX management system

C. Description:

1. The optical fiber source shall permit full end to end testing of Multimode, Single-mode and LOMMF optical fiber cabling fully compliant with industry standards and manufacturer recommendations.
2. Available source types and wavelengths shall be as follows:
   a. Multimode - 850nm LED and 1300nm LED.Versiv
   b. Single-mode – 1310nm FP Laser and 1550nm FP Laser.
   c. LOMMF – 850nm VCSEL and 1310nm FP Laser.

3. The power meter shall be calibrated to read 850, 1300, 1310 and 1550nm wavelengths.

D. Accessory Products:

1. Interface Adapters
   a. DTX Fiber Module for Multimode cable @ 850 and 1300 nm – Model No. DTX-MFM2
   b. DTX Fiber Module for Gigabit LOMMF cable @ 850 and 1310 nm – Model No. DTX-GFM2
   c. DTX Fiber Module for Single mode cable @ 1310 and 1500 nm – Model No. DTX-SFM2
   d. Optical Fiber Mandrels.

2. Fiber Microscope
   a. Magnification of 200X or 400X for end face inspection
   b. Optional requirements
      i. Video camera systems are preferred.
      ii. Camera probe tips that permit inspection through adapters are preferred.
      iii. It is preferable to use test equipment capable of saving and reporting the end face image.

   c. FiberInspector Mini Video Microscope – Model No. FT500.

PART 3 - EXECUTION

3.1 EXAMINATIONS

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

B. Verify telecommunications cabling is installed and supported, terminated, mounted in an appropriate housing or terminated on the applicable component and labeled prior to certification testing and documentation.

C. Verify certification tester universal interface adapters and manufacturer patch cords that enable permanent link verification are in new condition not indicating any twisting or kinking resulting from incorrect storage of the tester interface adapters.

D. Optical fiber patch cords shall be inspected to ensure connector surfaces are clean and free of defects that may affect testing results.

3.2 COPPER CABLE TESTING GENERAL REQUIREMENTS

A. Process:

1. Certification test 100% of the installed cabling plant including all backbone and horizontal four (4) pair UTP/ or F/UTP copper connections.
2. Follow manufacturers' instructions and recommended industry standards and guidelines to complete all TIA testing procedures to verify performance levels.
3. Follow manufacturer requirements for self-calibration procedures.
4. Perform all tests required by local authorities in addition to tests specified herein.
5. Update tester software to show specific project information including but not limited to:

    a. Date and time of testing
    b. Project name
    c. Field technicians name
    d. Cable identification number
    e. Cable manufacturer, type and part number

3.3 CATEGORY 6A COPPER CABLE TESTING REQUIREMENTS

A. General Requirements

1. Every cabling link in the installation shall be tested for:

    a. Wire Map
    b. Length
    c. Insertion Loss
    d. NEXT Loss
    e. PS NEXT Loss
    f. ACR-F Loss
    g. PS ACR-F Loss
    h. Return Loss
    i. Propagation Delay
    j. Delay Skew

in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard". This document will be referred to as the "TIA Cat 6 Standard."

2. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the Category 6A Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 6A Standard mentioned in A.1 above and as further detailed in Section B. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals).
5. The test equipment (tester) shall comply with the accuracy requirements for level IIIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).

6. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
7. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
8. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
9. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
10. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.
11. A representative of the end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.
12. A representative of the end-user has the right (at their discretion) to select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Section C.1. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

B. Performance Test Parameters

The test parameters for Category 6A cabling are defined in the ANSI/TIA-568-C.2 and are all tested automatically using the Category 6A Auto test with the Fluke DTX-1800 or Fluke DSX-5000 Cable Analyzer.

C. Test Result Documentation

1. The test results/measurements shall be transferred into a Windows™-Excel and in the Fluke LinkWare Cable Test Management Software format. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
2. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
3. General Information to be provided in the electronic database with the test results information for each link:

    a. The identification of the customer site as specified by the end-user
    b. The identification of the link in accordance with the naming convention defined in the overall system documentation
    c. The overall Pass/Fail evaluation of the link-under-test
    d. The name of the test limit selected to execute the stored test results
    e. The cable type and the value of NVP used for length calculations
    f. The date and time the test results were saved in the memory of the tester
    g. The brand name, model and serial number of the tester
    h. The identification of the tester interface
    i. The revision of the tester software and the revision of the test standards database in the tester

j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.

4. The detailed test results data to be provided in the electronic database for must contain the following information:
For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value
b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
c. Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair
e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

(1): Nominal Velocity of Propagation (NVP) expresses the speed of the electrical signals along the cabling link in relation to the speed of light in vacuum ($3x10^8$ m/second). Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an 'average' value for NVP is published for all four wire-pairs in a data cable.

(2): 'Margin' designates the difference between the measured value and the corresponding test limit value. For passing links, 'worst case margin' identifies the smallest margin over the entire frequency range; the point at which the measured performance is "closest" to the test limit.

3.4 FIBER OPTIC CABLE TESTING REQUIREMENTS

A. GENERAL

1. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
2. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

B. OPTICAL FIBER CABLE TESTING

1. Field-test instruments shall have the latest software and firmware installed.
2. Link and channel test results from the OLTS shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
3. Fiber end faces shall be inspected at 200X or 400X magnification. 200X magnification is suitable for inspecting multimode and single mode fibers. 400X magnification may be used for detailed examination of single mode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

a. It is preferable that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.

4. Testing shall be performed on each cabling segment (connector to connector).
5. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
6. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length.
7. Optical loss testing
   a. Backbone link
      iv. Multimode (OM4) backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI /TIA-526-14-B, One-cord reference method (Annex A)
      v. Single mode (OS2) backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI /TIA-526-7, Method A.1, Insertion Loss Using an Optical Power Meter – One Jumper Cable Measurement.
      vi. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
      vii. Use the One Reference Jumper Method specified by ANSI/TIA -526-14-B, Annex A and ANSI/TIA -526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

8. Magnified End Face Inspection
   a. Fibers shall be inspected at 250X or 400X magnification. 250X magnification is suitable for inspecting multimode and single mode fibers.

9. Length Measurement
   a. The length of each fiber shall be recorded.
   b. It is preferable that the optical length be measured using an OLTS.

10. Polarity Testing
    a. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

C. ADMINISTRATION

1. Test results documentation
   a. Test results saved within the field-test instrument shall be transferred into a Windows™-Excel and in the Fluke LinkWare Cable Test Management Software format. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
   c. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM, DVD or USB prior to Owner acceptance of the building. CD-ROM, DVD or USB shall include the software tools required to view, inspect, and print any selection of the test reports.
   d. Circuit IDs reported by the test instrument should match the specified label ID.
   e. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
      i. The identification of the customer site as specified by the end-user
      ii. The name of the test limit selected to execute the stored test results
      iii. The name of the personnel performing the test

iv. The date and time the test results were saved in the memory of the tester
v. The manufacturer, model and serial number of the field-test instrument
vi. The version of the test software and the version of the test limit database held within the test instrument
vii. The fiber identification number
viii. The length for each optical fiber (Optionally the index of refraction used for length calculation when using a length capable OLTS)
ix. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
x. The overall Pass/Fail evaluation of the link-under-test for OLTS measurements
xi. A picture or image of each fiber end-face and a pass/fail status of the end-face based upon visual inspection.

3.5 ACCEPTANCE OF TEST RESULTS

A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:

1. Optical loss testing
   a. Multimode and Single mode links
      i. The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-C.0.
         a) Link Attenuation (dB) = Cable_Attn (dB) + Connector_Attn (dB) + Splice_Attn (dB)
         b) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)
         c) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)
         d) Maximum allowable connector_loss = 0.50 dB
         e) Splice_Attn (dB) = number_of_splices * splice_loss (dB)
         f) Maximum allowable splice_loss = 0.3 dB
         g) The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

2. Magnified end face inspection
   a. Fiber connections shall be visually inspected for end face quality.
   b. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

B. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Section 3.4. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Section 3.4.

C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-SR, and 40GBASE-SR4 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss.

Performance specification for MM fiber at 850 nm

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		40GBASE-SR4	
	µm	(MHz• Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM1	62.5	200	275	2.38	33	2.5		2.4
OM2	50	500	550	3.56	82	2.3		2.2
OM3	50	1500		3.56	300	2.6	100	1.9
OM4	50	3500			400	2.9	150	1.5

3.6 REPAIR

A. Any connections failing to meet referenced standards or more stringent performance requirements stated above, must be removed and replaced with connections that prove, in additional testing, to meet or exceed the performance standards set forth.

3.7 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.8 CLOSEOUT ACTIVITIES

A. Contractor to submit all test results and any test documentation required prior to acceptance by the Owner.

B. Record copy and as-built drawings

C. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM, DVD or USB. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. CAD drawings are to incorporate test data imported from the test instruments.

D. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-built shall include all field changes made up to construction completion:

1. Field directed changes to pull schedule.
2. Field directed changes to cross connect and patching schedule.
3. Backbone cable routing or location changes.
4. Associated detail drawings.

END OF SECTION 27 08 00

SECTION 27 11 16 - COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Equipment Racks

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270526 – Grounding and Bonding for Communications Systems
2. Section 270553 – Identification for Communications Systems
3. Section 271119 – Communications Termination Blocks and Patch Panels

1.3 SUMMARY

A. Provides specifications for network cabinets, racks, and telecommunications enclosure components utilized to house various telecommunications infrastructure components within technology distribution spaces.

1.4 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS (4-POST)

A. Manufacturer’s List:

1. Chatsworth Products Inc. (CPI)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each infrastructure component selected shall address the particular requirements.
2. Select relay racks and components capable of supporting the telecommunications cable and equipment quantities required for each location.

C. Description:

1. Racks shall be used for mounting of patch panels, wire management, and network equipment in the MDF Rooms.
2. Racks shall be of high strength aluminum construction.
3. Minimum weight capacity of 1500 lbs. (680 kg).
4. Racks shall be supplied with (2) top angles.
5. Racks shall be 84 inch (2134 mm) high
6. Racks shall contain mounting dimension of a minimum of forty-five (45) rack units marked in a contrasting color.
7. Racks shall be bolted to slab at front and rear flanges and tied to overhead ladder rack for additional stability with threaded rod and Kindorf or the appropriate ladder rack mounting hardware.
8. Racks shall be provided with equipment mounting screws (50 per rack minimum).
9. Rack finish shall be Black.
10. Chatsworth Products Inc. QuadraRack 4-Post Frame Part No. 50120-703

D. Accessory Products:

1. Accessory mounting brackets to accept mounting of two (2) vertical plug strips, Chatsworth PN. TS1012713

2. Provide (2) APC Horizontal PDU (Nema L5-20P) at IDF

3. Provide Total (4) APC Vertical PDU (Nema L5-20P) at MDF

4. Grounding accessories as required to bond all removable rack parts to grounding system. Racks shall be equipped with a vertical Rack Grounding Busbar (RGB) bonded with a #6 AWG wire with green insulation to the nearest Telecom Grounding Busbar (TGB). Use lug type connectors at each end

2.2 HEAVY DUTY WALL MOUNTED RACK

A. Manufacturer's List:

1. Chatsworth Products Inc. (CPI)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each infrastructure component selected shall address the particular requirements.
2. Select relay racks and components capable of supporting the telecommunications cable and equipment quantities required for each location.

C. Description:

1. Racks shall be used for mounting of patch panels, wire management, and network equipment in the IDF Rooms.
2. Racks shall be of high strength aluminum construction.
3. Rack shall be 40RU
4. Rack shall be Black

5. Chatsworth Products Inc. Heavy Duty Equipment Rack Part No. 15321-724

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 EQUIPMENT RACKS & CABINETS

A. Process:

1. Install all racks per the manufacturer's recommended instructions.
2. Furnish and install equipment racks in each location as shown on the drawings, for the mounting of cable and Owner provided equipment. Bond the racks and cabinets to the mesh bonding network/signal reference grid or telecommunications grounding bus bar in the room or below the raised floor with # 6 AWG wire as specified in ANSI/TIA-607-B.
3. Anchor all racks and frames to the raised floor and cross brace to structure above.
4. Seismically brace the products indicated in this specification adhering to construction regulations relative to the buildings seismic zone.
5. Contractor shall request written authorization prior to drilling into any surface more than one and one half inch (1.5") in depth
6. Existing Cabinets to be relocated shall include as part of the contractor's preparation and staging work a visual inspection for missing or damaged material including accessories and power strips. Any irregularities shall be documented and submitted for verification to the Owner and A/E team

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 11 16

SECTION 27 11 19 - COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Optical Fiber Termination Shelves
2. Copper Patch Panels

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
3. Section 271313 – Communications Copper Backbone/Tie Cabling
4. Section 271323 – Communications Optical Fiber Backbone/Tie Cabling

1.3 SUMMARY

A. Provides specifications for wall and rack/cabinet-mounted blocks, patch bays, and patch panel components utilized to terminate various telecommunications infrastructure cabling and connectivity.

1.4 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 OPTICAL FIBER TERMINATION SHELVES

A. Manufacturer List:

1. Corning

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Suitable for mounting in standard EIA 19-inch racks. Each patch panel with quick release hinged front door, hinged rear door, slide out shelf, front facing label panel. Complete with coupler panels and couplers.
2. Each panel shall offer one or more of the following strain relief options: compression glands, or internal clips and entrapment of yarn based impact resistance
3. Each patch panel shall be able to handle a minimum (48) terminated elements in a (1) RMS footprint, including a 24-inch service loop in each fiber element inside the enclosure. The bulkhead adapters are to be segregated in such a way that it will be clear which coupler belongs to each fiber type.
4. Cable Management rings or guides shall be provided to allow individual elements to be stored in the panel without crushing, bending or straining each element.
5. Each panel shall be able to store fiber reserve within the parameter/requirement of the fiber cable manufacturer for minimum bending radius.
6. There shall be sufficient finger space around bulkhead adapters to allow connectors to be mounted and demounted readily.
7. Each patch panel shall be fitted with bulkhead adapters with ceramic alignment sleeves for all styles of connectors. Bulkhead adapters to be sourced from the same manufacturer as the connectors provided as a part of this project, or they are to be recommended by the manufacturer for use with the connector.
8. Panels shall accommodate Plug & Play MPO modules in addition to bulkhead adapters.
9. Panels shall accommodate splice trays as required.
10. Panels shall be sized as indicated on drawings.
11. Used for housing fiber optic backbone cables in all the IDFs and MDF
12. Corning 2RU Fiber Optic Enclosure Part No. CCH-02U

D. Accessory Products:

1. Provide any accessory products related to the optical fiber termination shelves to provide a complete and functional infrastructure system.
2. Coupler panels:
   a. 24-Fiber Multimode LC-LC OM4 MM Connector Panel – CCH-CP24-E4-P03SH
   b. 12-Fiber Single mode LC-LC OS2 SM Connector Panel – CCH-CP12-A9-PO3RH

2.2 COPPER PATCH PANELS – HORIZONTAL CABLES

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Modular RJ45 jack panels.
2. Flat style panels.
3. Panel finish shall be black.
4. Able to meet or exceed the channel specifications of the ANSI/TIA/EIA-568-C.2-10 standard for a Category 6A system up to 500 MHz
5. EIA/TIA T568B wiring scheme.
6. Suitable for mounting in standard EIA 19-inch racks.
7. Strain relief for each cable terminated on the connector. Provide strain relief bars on the rear of all panels.
8. Store cable reserve with no bends sharper than a 2-inch (50 mm) bend radius.
9. Provide sufficient finger space to allow connectors to be mounted and demounted readily.
10. Space for labeling of each individual connector.
11. Shall allow any individual cable to be terminated or otherwise handled without disturbing other cables.
12. Complete with designation strips
13. Used for Workstation and WAP cabling terminations as indicated on drawings.
14. Hubbell 24 Port Cat 6A Angled Patch Panel Part No. HP6A24A
15. Hubbell 48 Port Cat 6A Angled Patch Panel Part No. HP6A48A

D. Accessory Products:

1. Provide any accessory products related to the patch panels to provide a complete and functional infrastructure system

2.3 COPPER PATCH PANELS – BACKBONE CABLES

A. Manufacturer's List

1. Hubbell

B. Product Options

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. 110 to RJ45 patch panels.
2. Angled style panels.
3. Panel finish shall be black.
4. Able to meet or exceed the channel specifications of the ANSI/TIA/EIA-568-C.2 standard for a Category 5e system up to 100 MHz.
5. EIA/TIA T568B wiring scheme.
6. Suitable for mounting in standard EIA 19-inch racks.
7. Provided with a minimum of 24 connectors, as defined in this specification, housed in 1 RMU of usable rack height.
8. Strain relief for each cable terminated on the connector. Provide strain relief bars on the rear of all panels.
9. Store cable reserve with no bends sharper than a 2-inch (50 mm) bend radius.
10. Provide sufficient finger space to allow connectors to be mounted and demounted readily.

11. Space for labeling of each individual connector.
12. Shall allow any individual cable to be terminated or otherwise handled without disturbing other cables.
13. Complete with designation strips
14. Used for backbone cabling terminations as indicated on drawings.
15. Hubbell Cat 5E 24-Port Angeled Patch Panel Part No. HP5E24A

D. Accessory Products:

1. Provide any accessory products related to the patch panels to provide a complete and functional infrastructure system

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 COPPER PATCH PANELS

A. Process:

1. Install patch panels for the termination of all copper cables installed under this work. Mount the patch panels into the equipment racks as shown in the drawings. Provide patch panels complete with designation strips.
2. Provide optical fiber patch panels as shown on the drawings for the termination of optical fiber cables installed under this work. Provide patch panels complete with coupler panels, coupler modules, and cable designation strips.
3. Provide horizontal wire management panels between flat patch panels installed in each equipment rack and cabinets; angled patch panels do not require horizontal wire management panels.
4. Install all optical fiber and UTP components under the guidelines of the manufacturer's recommended instructions and per all TIA 568C standards and manufacturer-approved industry practices as shown in the T-series drawings.
5. The installation and performance parameters of all installed cable termination panels shall be verified by the contractor through TIA 568C testing procedures.
6. Label all cable termination panels to identify each port and each specific panel in accordance with the TIA-606-B labeling scheme approved by the Owner.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 11 19

SECTION 27 11 23 - COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Horizontal Cable Management Panels
2. Vertical Cable Management Troughs
3. Ladder Rack
4. Innerduct

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
2. Section 271119 – Communications Termination Blocks and Patch Panels

1.3 SUMMARY

A. Provides specifications for cable management components utilized inside each telecommunications distribution space to support the management of horizontal workstation cabling, backbone cabling, and patch cords.

1.4 RELATED DOCUMENTS

A. Architectural, Mechanical, Electrical, and all Technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results
2. Results for Communications

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE MANAGEMENT PANELS

A. Manufacturer's List:

1. Chatsworth Products Inc. (CPI)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. All horizontal cable management shall be provided in rack unit dimensions as noted in the drawings. Typical heights are 4 RMU
2. All 19" horizontal managers must have sufficient depth and surfaces to allow for Category 6A copper cables bend radii. Typically, (5) 4-inch (101 mm) deep horizontal distribution rings should be provided.
3. Horizontal cable managers shall be single sided and shall provide sufficient depth to allow for Category 6A copper and optical fiber bend radii internally and when entering and/or leaving the wire management frame.
4. All components of the cable management system shall be full metal or high-strength rigid plastic construction and black in color
5. Chatsworth Products Inc. Evolution Cable Management Panel, 4 RMU, Part No. 35441-704

D. Accessory Products:

1. Provide any accessory products related to the wire management components to provide a complete and functional infrastructure system.

2.2 VERTICAL CABLE MANAGEMENT TROUGHS

A. Manufacturer's List:

1. Chatsworth Products Inc. (CPI)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Used for organizing patch cords on front and incoming cables at rear of freestanding equipment racks.
2. Aluminum construction with grommet holes for cable pass through, protective edge guards, cable retaining latches, and solid cover.
3. Include plastic T-shaped cable guides with opening that align with each rack-mount unit space on the rack.
4. All vertical cable management on 2-post & 4-post equipment racks shall be 10-inches or 12-inches (254 mm) in width between racks unless otherwise noted on the drawings
5. All vertical cable management on 2-post & 4-post equipment racks shall be 6-inches (203 mm) in width at end of row unless otherwise noted on the drawings.

6. All vertical cable management on 2-post & 4-post equipment racks shall be 7-feet (2.1m) in height unless otherwise noted on the drawings.
7. All vertical cable management on 2-post & 4-post equipment racks shall be 24.5-inches (622 mm) in depth unless otherwise noted on the drawings.
8. Dual hinged, removable, full-length doors shall be provided on the front of the management.
9. Mounted directly to equipment racks between adjacent racks and at any open rack ends as shown on equipment elevation drawings.
10. Color: Black.
11. Chatsworth Products Inc. Evolution g2 Double Sided Vert Cable Man 10":
Part No. 35523-703
12. Chatsworth Products Inc. Evolution g2 Double Sided Vert Cable Man 6":
Part No. 35521-703

D. Accessory Products:

1. Velcro cable ties - Velcro strips ¾" wide, releasable and reusable 15'roll. Panduit Velcro cable ties or approved equivalent.
2. Provide any accessory products related to the wire management components to provide a complete and functional infrastructure system.

2.3 LADDER RACK

A. Manufacturer's List:

1. Chatsworth Product Inc. (CPI)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Open rung TELCO-style ladder type cable tray with runway dropouts, complete with splice hardware, runway termination hardware, and ceiling support hardware. Constructed of steel tubing with 12-inch (305 mm) rung spacing.
2. Size: As indicated on drawings.
3. Cross-members welded at 12-inch (305 mm) intervals.
4. Color: Black
5. Chatsworth Universal cable runway or approved equal.

D. Accessory Products:

1. Radius drop-cross member, radius drop-stringer, junction splice kit, butt splice kit, wall angle support kit, end closing kit, protective end caps, "L" bracket for ground wire support, 6" cable runway elevation kit.

2.4 INNERDUCT

A. Manufacturer's List

1. Tyton (or approved equivalent)

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements

C. Description:

1. 1 ¼" corrugated innerduct to be installed in conduit per direction shown on drawings. Innerduct to be labeled with tags indicating A, B, C

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. Adequate clearances of doors, riser spaces, and ceilings for all component of the telecommunications system.
3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 HORIZONTAL CABLE MANAGEMENT PANELS

A. Process:

1. Install all horizontal cable management per the manufacturer's recommended installation instructions, as indicated in the T-series drawings.
2. All cable bundles inside the telecommunications rooms shall be secured with Velcro™ cable wraps; plastic wire ties are not acceptable.
3. Velcro™ wraps shall not be pulled tight enough to kink the cable jacket.

3.3 VERTICAL CABLE MANAGEMENT TROUGHS

A. Process:

1. Install all vertical cable management troughs per the manufacturer's recommended installation instructions, as indicated in the project drawings. Follow all mounting and support guidelines

3.4 LADDER RACK

A. Process:

1. Install all ladder rack per the manufacturer's recommended installation instructions, as indicated in the project drawings. Follow all mounting and support guidelines.

3.5 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.6 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 11 23

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. 25-Pair Category 5E Cable
2. RG6 Coaxial Cable

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 270800 – Commissioning of Communications
3. Section 271116 – Communications Cabinets, Racks, Frames and Enclosures
4. Section 271119 – Communications Termination Blocks and Patch Panels

1.3 SUMMARY

A. Provides specifications for UTP copper tie cabling to distribute network signals between telecommunications distribution spaces.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 BACKBONE MULTI-PAIR UTP CABLE

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. 25-Pair Binder Unshielded Twisted Pair Cable
2. Physical Specifications: 24 AWG, solid copper conductors, 100 Ohm nominal impedance +/ 15%
3. Electrical characteristics: Superior to the individual characteristics established in ANSI/TIA/EIA-568-C.2 for Category 5e cable performance.
4. Supports 10BASE-T, 100BASE-T, TP-PMD, Voice, Multimedia, and 155 Mb/s ATM.
5. Mechanical requirements:
   a. Conductors: 24 AWG - solid bare copper
   b. Outer Jacket: PVC
   c. Conductor Insulation: Polyethylene
   d. UL listed, Type CMP (plenum rated)
6. Cable color shall be Gray
7. Used for building backbone cabling distribution as indicated on the drawings.
8. Hubbell Category 5E Backbone 25-Pair UTP cable, Part No. C5ELPPGY

2.2 RG6 COAXIAL CABLE

A. Manufacturer's List:

1. Belden

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. RG 6 Coaxial cable indoor rated
2. 75 ohms
3. Minimum 60% Aluminum braid
4. 18 AWG
5. SCBA Compliant
6. Contractor shall provide 20' slack at both ends of cable run connecting MDF to IDF
7. Belden RG 6 18 AWG BCCS, Foil + Braid, CMR Part No. 1829R

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 COPPER CABLING

A. Process:

1. Install all copper tie cable per the manufacturer’s recommended installation instructions, under the guidelines of TIA 568-C and BICSI, and in quantities indicated in the T-series drawings.
2. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
3. Tie cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.
4. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI guidelines.
5. Install tie cables “end-to-end” without splicing between the intended termination points within each telecommunications room with attention paid to aesthetic means and methods when routing cabling within IT spaces.
6. No tie cable shall be left unsupported for more than three (3) feet vertically or horizontally at any time.
7. All tie cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 13 13

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Multimode Fiber Optic Cable
2. Single mode Fiber Optic Backbone Cable

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 270800 – Commissioning of Communications
3. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
4. Section 271119 – Communications Termination Blocks and Patch Panels
5. Section 271323.13 – Communications Optical Fiber Splicing and Terminations

1.3 SUMMARY

A. Provides specifications for optical fiber tie cabling to distribute optical network signals between telecommunications distribution spaces.

1.4 RELATED DOCUMENTS

A. Architectural, Mechanical, Electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 BACKBONE MULTIMODE FIBER OPTIC CABLE

A. Manufacturer's List:

1. Corning

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Tight-buffered Multimode fiber optic cable with a plenum-rated outer jacket.
2. Total strand count as noted in drawings.
3. ISO/IEC 11801 – OM4 grade fiber optic cable.
4. Multimode Distribution Cable Elements. The Multimode Optical Fiber Cable shall as a minimum conform to the following specifications.
    1) 50/125-micron multimode optical fiber cable (tolerances 50 +/-2 micron, 125 +/-2 micron) with glass core and cladding
    2) Graded refractive index profile
    3) Attenuation coefficient at 850 nm of 0.7 dB/km or less
    4) Attenuation coefficient at 1300 nm of 0.7 dB/km or less
    5) Serial 1 Gigabit Ethernet distance of 1000m at the 850 nm wavelength.
    6) Serial 10 Gigabit Ethernet distance of 550m at the 1300 nm wavelength
    7) Core non-circularity +/- 6% maximum
    8) Core/ cladding offset 3.0-micron maximum
    9) Numerical aperture 0.275 (+/- 0.015)
    10) Individual optical elements distinguishable at ends by color-coded buffered coatings conforming to ANSI/TIA 598-C - Color Coding of Fiber Optic Cables.
    11) Individual glass elements proof tested at 100 Kpsi (100,000 lbs. per square inch)

5. UL listed, Type OFNP, used for:
    a. Intrabuilding IDF, MDF data backbone cabling distribution
    b. Corning 24 Strand Multimode Fiber Optic Cable Part No. 024T81-33190-24
    c. Cable shall meet the specification for fiber optical cable detailed in the ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard

2.2 SINGLEMODE FIBER OPTIC CABLE – BACKBONE

A. Manufacturer's List:

1. Corning

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Singlemode fiber optic cable with a riser-rated outer jacket.
2. Total strand count as noted in drawings.
3. ISO/IEC 11801 – OS2 grade fiber optic cable.
4. Multimode Distribution Cable Elements. The Multimode Optical Fiber Cable shall as a minimum conform to the following specifications.
    1) 50/125-micron multimode optical fiber cable (tolerances 50 +/-2 micron, 125 +/-2 micron) with glass core and cladding
    2) Graded refractive index profile
    3) Attenuation coefficient at 850 nm of 0.7 dB/km or less
    4) Attenuation coefficient at 1300 nm of 0.7 dB/km or less
    5) Serial 1 Gigabit Ethernet distance of 1000m at the 850 nm wavelength.
    6) Serial 10 Gigabit Ethernet distance of 550m at the 1300 nm wavelength
    7) Core non-circularity +/- 6% maximum
    8) Core/ cladding offset 3.0-micron maximum
    9) Numerical aperture 0.275 (+/- 0.015)
    10) Individual optical elements distinguishable at ends by color-coded buffered coatings conforming to ANSI/TIA 598-C - Color Coding of Fiber Optic Cables.
    11) Individual glass elements proof tested at 100 Kpsi (100,000 lbs. per square inch)
5. UL listed, Type OFNP, OFNR used for:
    a. Intra building data backbone cabling distribution
6. Corning 12-Strand OS2 Distribution fiber cable Part No. 012E81-33131-24

D. Cable shall meet the specification for fiber optical cable detailed in the ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 OPTICAL FIBER CABLE

A. Process:

1. Install all cable per the manufacturer’s recommended installation instructions, under the guidelines of TIA 568-C and BICSI, and in quantities indicated in the series drawings.
2. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
3. Cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.

4. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI guidelines.
5. Install cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No cable shall be left unsupported for more than three (3) feet vertically or horizontally at any time.
6. All cable shall be securely fastened to the termination shelf in a way that does not damage the optical fiber strands or impede the performance of the media. This secure fastening method shall also serve to insure a secure termination environment.
7. A minimum of three feet (3'-0") of each optical fiber strand shall be left protected within the termination shelf for any future re-termination of a particular optical fiber strand.
8. All cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 13 23

SECTION 27 13 23.13 - COMMUNICATIONS OPTICAL FIBER SPLICING AND TERMINATIONS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Fusion Splicing Device

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270800 – Commissioning of Communications
2. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
3. Section 271119 – Communications Termination Blocks and Patch Panels
4. Section 271323 – Communications Optical Fiber Backbone Cabling

1.3 SUMMARY

A. Provides specifications for optical fiber cable termination and splicing for each strand of optical fiber inside termination shelves.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 FUSION SPLICING DEVICE

A. Manufacturer's List:

1. Fujikura
2. Sumitomo Electric Lightwave

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. The fusion device shall be portable, fully automatic and compact.
2. Splicer electrodes shall contain an arc-stabilizing feature to prevent spontaneous position shift of the arc emission zone to reduce the average splice loss by up to 50% and also the standard deviation compared to standard electrodes. The splicer shall require minimal maintenance, allowing up to 7000 splices between cleanings.
3. Procedures such as pre-alignment, cleaning, gap-setting, cleave angle monitoring, core-to-core alignment and glass fusion shall be microprocessor-controlled. Multiple splice programs with individual parameter settings shall be selectable, with seven pre-set single-mode and two multimode programs.
4. Course pre-alignment shall be performed automatically; therefore, accurate manual pre-alignment of the fibers shall not be necessary. Precise pre-alignment in z-axis shall be automatically performed with two-step motors. Fine positioning and final alignment of the fibers in three (x, y and z) directions shall be automatically performed with piezo-ceramic actuators, which have a positioning resolution better than 0.1 μm.
5. Upon completion of the splice, the splice loss shall be evaluated automatically. The splice loss value shall be displayed on the LCD display in decibels (dB).
6. The splicer shall be compliant with FCC CISPR 22 EMI and with the "Electromagnetic Compatibility" directive 89/336/EEC and the low voltage directive 73/23/EEC (applicable to only the battery charger).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 FUSION SPLICER DEVICE

A. Process:

1. Follow manufacturer's instructions at all times when operating the optical fiber fusion splicing device. Pay particular attention to cleanliness and axis alignment.
2. The technician shall utilize the integrated tensile testing function of the splicing device after each splice to analyze the strength of the fiber joint. The tensile testing load shall be 1.5 N (0.34 lbf) and shall be applied for approximately one second. Any splice failing the tensile test shall be re-spliced immediately.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 13 23.13

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. 4-pair UTP cable – Category 6A

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 270800 – Commissioning of Communications
3. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
4. Section 271119 – Communications Termination Blocks and Patch Panels
5. Section 271543 – Communications Faceplates and Connectors

1.3 SUMMARY

A. Provides specifications for 4-pair copper horizontal workstation cabling to distribute network signals from telecommunications distribution spaces to workstation outlet locations.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 4-PAIR UTP CABLING

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The manufacturers noted above shall be the only manufacturers acceptable to the Owner and Design-Builder.

C. Description

1. One (1) 4-pair UTP Category 6A cable with a plenum rated outer jacket.
2. Physical specifications: 4 twisted pair – 23 AWG, solid copper conductors, 100-Ohm nominal impedance +/ 15%.
3. Electrical characteristics: Able to meet or exceed the channel specifications of ANSI/EIA/TIA-568-C-2.10 standard, "Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6A Cabling", with available bandwidth up to 500 MHz
4. Mechanical requirements:
   a. Conductors: 23 AWG - solid bare copper
   b. Outer Jacket: Flame retardant PVC
   c. Conductor Insulation: FEP
   d. Break Strength: Minimum 90 lbs.
5. Color Code:
   a. Jacket: Blue for all Data locations
   b. Jacket: Yellow for Security Camera locations only
6. Insulation:
   a. Pair 1: White/Blue - Blue/White
   b. Pair 2: White/Orange - Orange/White
   c. Pair 3: White/Green - Green/White
   d. Pair 4: White/Brown - Brown/White
7. UL listed, Type CMP.
8. Hubbell Category 6A Part No. C6ASPB (Blue)
9. Hubbell Category 6A Part No. C6ASPY (Yellow)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. The TRs are the size shown on the project drawings.

3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 4-PAIR CABLING INSTALLATION

A. Process:

1. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568C and BICSI standards, and in quantities indicated in the drawings.
2. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in TIA/EIA 568C and BICSI guidelines. Also refer to the cable manufacturer's specifications for exact cable requirements per the particular cable type.
3. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.
4. Contractor shall ensure that all TIA/EIA and industry standards are met with special regards to maximum stripping length of cable jackets. No four (4) pair F/UTP cables shall have more than ½ inch (12.7 mm) of cable jacket removed beyond the termination points.
5. Install the horizontal cabling with attention paid to aesthetic means and methods when routing cabling within IT spaces.
6. All cabling distributed horizontally through metal stud framing shall have plastic protective bushings inserted to protect cables prior to installation.
7. All cables shall be clearly labeled on both ends and in an accessible location no more than 6-inches (152 mm) from the cable ends.
8. The owner reserves the right to specify a new location for any outlet or equipment without increasing contractor unit cost – providing that the new location is specified prior to roughing-in of technology cable and is not farther than 10-feet (3m) away from the original location specified.
9. When conduits, sleeves and cable trays (provided under the electrical work) are not present, support all cables with J-hooks and/or cable straps mounted to the ceiling above. Provide supports at maximum 5-foot intervals. Do not install more than 24 cables in any single J-hook for support. When more than 24 cables must be installed, provide additional J-hooks or cable straps.
10. Install workstation cable in accordance with this Specification, the approved Cable Termination Schedule, the manufacturer's recommendations, and the Telecommunications Distribution Drawings.
11. After dressing each cable to its final location, remove only enough jacketing to allow the conductors to be splayed and terminated in a neat and uniform fashion. Every effort shall be made to maintain jacketing integrity by removing only as much jacketing as is practical to accomplish termination. For twisted pair cables, maintain the manufacturers' twisting of the wire pairs through to the point of termination.
12. Install all U/UTP cable according to manufacturer's installation standards.
13. Terminate all cables neatly, with enough slack to pull off, test, re-cut and re-terminate each cable as needed.
14. When pulling cables through conduits, leave in-place all draglines for future use.
15. Provide a 12-inch (305 mm) service loop at all workstation locations unless otherwise noted. The workstation loops shall be stored at the top of each conduit stub-up in the accessible ceiling area, or wherever it is possible to be concealed and supported.
16. Provide Velcro tie wraps to organize and bundle all category rated cabling installed under this Work. Install the approved Velcro strips long enough to overlap at least 1.5 inches (38 mm) around the installed cables. Plastic tie wraps shall not be used.
17. Do not allow telecommunication cables to run parallel with electrical cables/conduits, unless they are separated by a minimum of 12-inches (305 mm).
18. Any telecommunications cable that must cross over electrical cables/conduits shall do so only at 90-degree angles.

19. Do not lay telecommunications cables unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top.
20. Maintain manufacturer's recommended minimum bend radius of the cables. Do not stretch, stress, tightly coil, bend or crimp the workstation cables during the installation or when leaving them out of the way of other trades during the staging of the work. The Contractor, at the Contractors sole expense, shall replace all abused or stressed cables.

3.3 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 15 13

SECTION 27 15 43 - COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. UTP Connectors
2. Coax Connectors
3. Outlet Housing Components (faceplates etc.…)

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 270800 – Commissioning of Communications
3. Section 271513 – Communications Copper Horizontal Cabling

1.3 SUMMARY

A. Provides specifications for fiber optic backbone, horizontal workstation cable termination components, and outlet housing components. Includes wall-mount, floor-mount, and ceiling-mount components to support the various workstation outlets throughout the cabling plant.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 UTP CONNECTORS

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Non-keyed 8 pin modular connectors, suitable to terminate UTP 4-pair cables. Suitable to be mounted in corresponding faceplate, mounting plate or surface mount box.
2. Provide Category 6A rated eight-conductor RJ45 connector.
3. EIA/TIA T568B wiring scheme.
4. Performance criteria: Able to meet or exceed the channel specifications of the ANSI/TIA/EIA-568-C.2-10 standard for Augmented Category 6A system performance up to 500 MHz
5. Color: Multiple Different Colors, to be confirmed before ordering
6. Colors to be coordinated with Architect during submittal phase
7. Hubbell Category 6A Connector Part No. HJU6AW

D. Accessory Products:

1. Color-coded Icons – furnish and install (1) color-coded icon for each UTP connector installed in this project. Exact colors and styles shall be determined during product submittal review.
2. Provide any accessory products related to the UTP connectors required to provide a complete and functional infrastructure system.

2.2 COAX CONNECTORS

1. Belden

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. Exact connector type shall be provided prior to ordering. For bidding purpose please price Direct TV approved Compression connectors

2.3 OUTLET HOUSING COMPONENTS

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description:

1. All outlet housings at the various technology outlet locations shall provide the designated number modular insert ports as indicated in the drawings.
2. All flush-mounted faceplates shall be available in one (1), two (2), three (3), & four (4) port configurations of the same single gang style outlet Faceplates for wall-mounted phones shall be one (1) port stainless-steel single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
3. Faceplates for flush floor mounted outlets shall be coordinated with the floor box that will be selected and installed outside the scope of this section.
4. System furniture faceplates shall be capable of fitting in the furniture system selected by the Owner. Quantity of furniture faceplates shall satisfy outlet jack requirements. Furniture faceplate extenders shall be used (if required) to maintain proper bend radii within the furniture raceway/pathway.
5. Surface mounted boxes shall be capable of the quantity of outlet jack requirements at each outlet locations indicated in the drawings. Provision (1) surface mount outlet box at all furniture-mounted outlet locations and Wireless Access point locations in the ceiling
6. All surface mounted boxes installed above ceiling in plenum air spaces shall be plenum rated.
7. Surface-raceway mounted outlets shall be capable of being installed within surface-raceway provided and installed by others. Contractor to provide appropriate mounting bezels and keystone jacks (as necessary) for proper mounting within surface raceway.
8. All outlet-housings shall provide a clear TIA/EIA 606-B labeling location for both the individual outlet port and the entire outlet housing location, unless otherwise indicated in the project drawings.
9. All faceplates shall be provided in a color that matches the electrical trim color unless otherwise noted in the drawings. Colors to be coordinated with Architect during submittal phase.

D. Accessory Products:

1. Provide any accessory products related to the workstation outlet housing components required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

B. Confirm all housings including back boxes, floor boxes and poke-through provided for the telecommunications connectivity system will support the installation of project approved manufacturer components prior to purchase of the components described in this specification.

3.2 UTP CONNECTORS

A. Process:

1. Install all connectors under the guidelines of the manufacturers' recommended instructions and per all TIA-568-C standards, BICSI guidelines, and manufacturer approved industry practices.
2. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade contractor through TIA-568-C testing procedures.
3. Color of all connectors shall be coordinated with the Architect and/or Owner before purchase and installation.

3.3 OUTLET HOUSINGS

A. Process:

1. Color of all outlet housing components shall be coordinated with the Architect and/or Owner before purchase and installation.
2. All technology outlets located on walls shall be flush mounted, level and plumb.
3. All technology outlets shall be mounted at right angles and parallel to the floor, unless installation requirements or design dictate otherwise.
4. Install blank inserts in outlet housing spaces that are not being filled with cable termination modules. Blank inserts shall match the workstation housing color, unless otherwise indicated in the drawings.
5. All outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box/floor-feed. If the cable is exposed prior to entering furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.
6. All outlet housings as well as each individual utilized port must be labeled in accordance with the Owner-approved labeling scheme.

3.4 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.5 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 15 43

SECTION 27 16 19 - COMMUNICATIONS PATCH CORDS AND STATION CORDS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. 4-pair UTP Patch cords
2. Coax Patch Cords
3. Fiber Optic Patch Cords

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Furnish the following items for installation by the designated Sections

1. Section 271619 - Communications Patch Cords, Station Cords, And Cross Connect Wire
   a. 4-pair UTP patch cords

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 270553 – Identification for Communications Systems
2. Section 270800 – Commissioning of Communications
3. Section 271119 – Communications Termination Blocks and Patch Panels
4. Section 271543 – Communications Faceplates and Connectors

1.3 SUMMARY

A. Provides specifications for 4-pair copper horizontal workstation cabling to distribute network signals from telecommunications distribution spaces to workstation outlet locations.

1.4 RELATED DOCUMENTS

A. Architectural, mechanical, electrical, and all technology drawings.

1.5 REFERENCES

A. Codes and Regulations: (Note: Reference Division 01 for specific code versions governing the work in addition to the information noted below).

1. Refer to Section 270500 – Common Work Results for Communications

PART 2 - PRODUCTS

2.1 COPPER PATCH CORDS

A. Manufacturer's List:

1. Hubbell

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.

C. Description

1. Physical Specifications: 4-pair, 24 AWG stranded copper UTP cable, with male 8-pin modular RJ45 plugs with insert-molded strain relief on both ends.
2. Performance Characteristics: Able to meet or exceed the channel specifications of the ANSI/TIA/EIA-568-C.2-10 standard for Category 6A cable up to 500 MHz
3. All patch cords supplied must comply with ANSI/TIA/EIA-568-C.2-1, Production Modular Cord NEXT Loss Test Method, and Requirements for UTP Cabling.
4. Wiring: T568B.
5. Contractor shall provide and include into the bid sum the price for the patch cords shown in the following quantities:
   a. @ IDF/MDF Closet:
      1) Contractor shall furnish and install (1) Category 6A copper patch cord per cable installed. Patch cords shall be multi-length with minimal slack.

   b. @ Workstation/Outlet End:
      1) Contractor shall furnish and turn over (1) Category 6A copper patch cord per faceplate installed.
      2) Exact patch cord lengths shall be provided prior to ordering.

6. Hubbell Category 6A Patch Cord Part No. HC6ABxx "xx"-Length

2.2 COAX PATCH CORDS

A. Manufacturer's List:

1. Belden

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements

C. Description

1. @ Workstation/Outlet End:
   a. Contractor shall provide (1) coax patch cord per cable installed.
   b. Exact patch cord lengths shall be provided prior to ordering.

2.3 FIBER PATCH CORDS

1. Contractor shall provide and include into the bid sum the price for the patch cords shown in the following quantities:

   a. Corning SM & MM Fiber Patch Cords @ xxx Feet, connectors to be determined as per client direction
   b. For pricing purposes, include twenty (25) patch cords to furnish & install

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:

1. Electrical requirements (conduit installation and capacity)
2. The MDF is the size shown on the project drawings.
3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions

3.2 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.

B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 27 16 19

SECTION 27 41 16 - AUDIOVISUAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Audiovisual equipment/systems and related control systems & programming.

B. Related Work

1. Audiovisual Contractor shall coordinate with the Structured Cabling Contractor for connection of all network enabled AV equipment to the structured cabling system (twisted pair and coaxial cabling).
2. Audiovisual Contractor shall coordinate with the Owner for connection of all network enabled AV equipment to Owner provided network switches, PoE power, wireless access points, VoIP interfaces as indicated on the drawings and equipment lists.
3. Audiovisual Contractor shall coordinate with the General Contractor and Electrical Contractor for final locations and routing of all audiovisual infrastructure including power, empty low voltage backboxes/conduit, required fire rated penetrations supporting all audiovisual equipment.
4. Audiovisual Contractor shall coordinate with the General Contractor and Miscellaneous Metals Contractor for location and attachment method of all structure/support systems provided under this scope of work for displays, video walls, speakers, cameras, racks and all other audiovisual equipment that is secured to the building.
5. Audiovisual Contractor shall coordinate with General Contractor for site logistics, schedule and access.

1.2 GENERAL CONDITIONS

A. The General Conditions, Requirements, and Special Provisions, of the larger body of specifications, of which this specification is a part, are hereby made a part of this specification. In the event that any clauses or provisions of the larger body of specification conflict with the letter or intent of this specification, the Contractor shall immediately notify the Consultant for clarification and direction.

1.3 THE SPECIFICATION

A. The “Specification” is defined as the body of documentation provided to the Contractor with the Request for Quotation, as well as all addenda to said documentation. Throughout this document, words such as “herein” refer to the entire Specification, and not just this written document.

1. The Specification includes, but is not limited to:

a. This written specification document.

b. The attached Audiovisual Systems Equipment List

c. All drawings, as listed in the List of Drawings or indicated on the drawing package cover page.

d. Additions and/or modifications as detailed in written addenda.

e. Additions and/or modifications as detailed in drawing additions or reissues.

B. Definition of Terms

1. Within this section of the specification, the following definitions shall apply:

2. The term “Owner” is used to indicate: Vassar College

3. The term “Architect” is used to indicate: Frederick Fisher and Partners

4. The term "General Contactor" or "Construction Manager" is the entity responsible for fit out of the interior spaces and coordination of all subcontractors

5. The term “Consultant” is used to indicate: Cerami & Associates

6. The term “Bidder” is used to indicate that entity generating the bid response.

7. The term “Contractor” is used to indicate the successful Bidder to whom the Owner has awarded the contract.

8. The term “Furnish” is used to indicate the responsibility to procure and ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.

9. The term “Install” or “Installation” is used to indicate the responsibility of receiving the item at the job site, assuring adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.

10. The term “Provide” is used to indicate the responsibility to both “Furnish” and “Install”.

11. The term “Provided by Others” shall refer to material and work, which is related to this contract, but has been provided by parties other than the AV Contractor. An example might be in reference to a projection screen installed during building construction but requiring interface to the AV control system.

12. The terms “NIC” and “Not in Contract” are equivalent to “Provided by Others”.

13. The term “OFCI” (Owner Furnished Contractor Installed) shall refer to equipment that will be furnished by the Owner for installation by the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.

14. The term “Installation Materials” shall reference installed cable, loose cable, terminations, cable management, voice/data/video patch cords, adapters, I/O panels, cable dressing, lacing bars, copper bus bars, labels, rack shelves, rack mounts, power strips/distribution and other materials as needed to install the systems defined herein.

15. The term “shall” is mandatory; the term “will” is informative; and the term “should” is advisory.

1.4 BIDDER QUALIFICATIONS

A. Unless superseded by the General Conditions or Owner’s Representative request for proposal documents the following qualifications are required for any bidder of this scope of work.

B. Contractor Qualification Requirements: Bidder shall submit on or before the date of the Pre-Bid Meeting evidence of his/her qualifications to perform the work specified. Contractor qualifications shall be the most current information available but not more than one year old. Submit one copy of documentation to both Owner and Consultant for review and approval. Transmit documentation to be received no later than the scheduled time of Pre-Bid Meeting. Materials shall include:

1. Corporate Profile
2. Location of Corporate Headquarters
3. Number of offices and locations
4. Location of office assigned to this project
5. Corporate History
6. How Many years in this business?
7. Under what former names have your organization operated
8. Date(s) of incorporation
9. State of incorporation
10. Officers names and addresses

C. Litigation Experiences within the Last 5 Years

1. Project Related:

    a. Nature of Litigation
    b. Plaintiff or Defendant
    c. Outcome

2. Non-Project Related

    a. Nature of Litigation
    b. Plaintiff or Defendant
    c. Outcome

D. Number and Type of Full-Time Staff

1. Total number of employees
2. Number of design staff
3. Number of installation staff
4. Number of project management staff
5. Number of software programming staff

E. Identify key personnel that will be assigned to this project including:

1. Project Executive
2. Project Manager
3. Systems Designer
4. Crew Chief/Superintendent/Lead Technician

5. Systems Programmer

6. Commissioning Agent

7. Trainer

F. For each Individual listed above provide a resume that includes:

1. Office Location

2. Percentage of individual's time that will be allocated to this project

3. Work History

4. Previous Project Experience

5. Length of Employment

6. Certifications: CTS, CTS-D, CTS-I, RCDD, PMP, Certified Control System Programmer, Certified DSP Programmer, video projection manufacturer specific certification, other.

7. The contractor's lead installer shall hold a current CTS-I (Certified Technology Specialist – Installation) certification from InfoComm International, and/or a current EST-L2 (Electronic Systems Technician) certification from NSCA. The Contractor shall submit the name of the lead installer and certification expiration dates.

8. Due to the potential complexity of the control system, a manufacturer certified software programmer shall be required to author the programming components of this project. The Contractor shall include in the bid response, the name of the manufacturer certified person or entity that will provide programming for the remote control system. The resume shall include a listing of years of experience and include a statement of manufacturer authorization, certification type, date of certification and the certificate number.

9. The project will utilize Digital Media Systems from one of several approved manufacturers. The Contractor shall provide documentation listing project team member(s), named in Section 1.4.D above, who will work on the project and who are manufacturer certified for all systems included in these Specifications with active certification. The documentation shall include a listing of years of experience and include a statement of manufacturer authorization, certification type, date of certification and the certificate number.

10. The project will utilize Digital Signage and Video Distribution System products from one of several approved manufacturers. The Contractor shall provide documentation listing project team member(s), named in Section 1.4.E above, who will work on the project and who are manufacturer certified for all systems included in these specifications with active certification. The documentation shall include a listing of years of experience and include a statement of manufacturer authorization, certification type, date of certification and the certificate number.

11. This project will utilize union installation labor. The Contractor shall provide documentation indicating if union labor will be provided by the Contractor or a Contractor designated and managed sub-contractor. The Contractor shall indicate the company name, address and contact information for the intended union sub-contractor included in the audiovisual bid.

G. Resources

1. A manufacturers' line card for products in which the Contractor is an authorized Distributor or Dealer. Include date initially authorized.

2. A list of any manufacturers' specialized technical certifications or designations held by the Contractor.

3. A list of manufacturers for whom the Contractor is an authorized service center.

4. A list of computer software and/or systems owned by the Contractor, which will be used to communicate, measure, draw, and/or document the project.

5. A list of system test equipment owned and used by the Contractor, including manufacturer, model number and, where applicable, latest software revision.

H. References

1. Include three projects of:

   a. Similar scope and scale.

   b. Similar technology applications

   c. Provide project cost for each

2. Include three project references, including:

   a. Contact name

   b. Institution name

   c. Phone number

   d. E-mail address

3. List any past projects where Contractor has worked with the Owner, Consultant, Architects, or Construction Manager who are part of this project team.

I. Subcontractors

1. A list of all subcontractors proposed for use on the Project.

2. For each subcontractor proposed:

   a. Subcontractor firm name

   b. Name(s) of subcontractor firm principal(s)

   c. Description of subcontractor firm sub-specialty

   d. Subcontractor firm qualifications and justification for subcontracting

   e. Acceptability of subcontractors shall be at the sole discretion of the Owner.

1.5 SITE CONDITIONS

A. Labor and Physical Access

1. The Bidder shall be responsible for investigating any potential conflicts with site-related or union-related issues regarding use of personnel, scheduling, access to the site, storage of tools and equipment on-site, and other areas of potential conflict. If these issues impact the Bidder's bid response, the impacts on cost and schedule should be clearly noted in the bid response.

B. Equipment Delivery and Storage

1. Costs of all shipping to the site, and of all storage requirements, shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements, and to coordinate with the authorized personnel at the site, for the proper acceptance, handling, protections, and storage of equipment so delivered.

C. Refuse

1. The Contractor shall keep the site and building free of all debris and clutter, to the satisfaction of the Owner or Construction Manager. On a daily basis, the Contractor shall remove refuse and rubbish related to the specified work from the site and building and shall leave the relevant areas and equipment clean and in an operational state. The Contractor shall be responsible for repairing any damage caused to the site and building by the Contractor's installation activities, at no cost to the Owner.

1.6 SCOPE OF WORK

A. General: Provide audio visual systems design, engineering, and installation within all phases and spaces of the project, as defined by the related documents. Systems shall include all devices, equipment, installation, programming and commissioning in accordance with requirements of the contract documents and drawings.

B. The work detailed within the contract documents has been specified to meet certain requirements for performance, appearance, and costs. It shall be the responsibility of the Contractor to implement the guidelines and requirements contained in the contract documents and translate them into a complete design package containing all elements necessary for a complete, operational, and functionally integrated Audio Visual System(s).

C. The Contractor shall provide complete, turnkey multimedia systems performing all of the services and functions as described herein, together with all other apparatus, cable, materials, labor, tools, transportation, and any other resources necessary to provide a complete and working system.

1. The included Audiovisual Systems Equipment List is NOT a complete bill of materials and includes major components that the Owner has identified as required or preferred.

D. Specifically, the work shall include, but is not limited to:

1. Communicating and coordinating with the Owner, Consultant, Architect, and other trades complying with all requirements as defined under this Scope of Work and elsewhere, to fulfill all requirements of this specification.

2. Generating and submitting Shop Drawings as required for approvals and As-Built drawings as specified herein.

3. Providing all cable and pull strings in conduits for the specified systems.

4. Furnishing and/or installing all equipment as specified.

5. Installing Owner supplied equipment as specified.

6. Take delivery of all Owner supplied components and equipment, excluding Room PCs, at Contractor's staging facility for integration into AV equipment racks.

a. No Owner furnished equipment has been identified at this time as previously used in existing facilities.

7. From the initial point of delivery Contractor shall be responsible for storing, integrating and maintaining as part of the system warranty all Owner supplied components.

8. Prior to installation Contractor shall test and verify all functions of Owner supplied components and equipment previously used in existing Owner's facility. Contractor shall provide a summary report of existing Owner supplied equipment and document any defects or service issues that would prevent existing equipment from reuse as part of this work.

9. Coordinate with Owner's content provider to determine optimal resolution and format for any Owner provided content. Stand up the content playback system prior to installation and load initial content samples for validation of playback system final configuration and settings. Demonstrate content playback operation and configuration to Owner's content provider for approval prior to final implementation of the content/playback systems.

10. Take delivery of initial graphic content and audio (including licenses, accounts or other means for accessing pre-packaged or streaming content). Load/enable all content and prepare initial templates or configuration files in all content management/playback systems configured for the display and audio systems provided under this scope of work.

11. Coordinate video conference endpoint provisioning with the Owner's network and the Owner's existing video conference bridge system or outsourced video conference bridging service.

12. Furnishing all lifts, ladders, scaffolding or other resources as needed for proper safe installation. Coordinating with other trades as needed.

13. Interconnecting all components, both internal and external to rack cabinets.

14. Providing patch cables for connection of all IP-enabled audiovisual equipment to associated data network outlets, including but not limited to Owner supplied Room computers, production computers, laptop connections, control system processors, codecs, IP cameras, and projectors. This applies to all equipment installed by the Contractor, including Owner-Furnished (OFCI) items. Coordinate patch cable requirements with the greater building-wide structured cabling system.

15. Contractor shall coordinate and secure, from the Owner, the IP configuration parameters such as DHCP, IP addresses, subnet information, VLAN setup & authorization, and the like for use by Ethernet equipped system components. As part of this coordination, Contractor shall create a device tracking document sortable by room, floor or equipment type and including mac address, serial number, network plate and patch number and network configuration parameters. The Contractor shall coordinate the installation and configuration of these devices with the Owner's IT department and/or designated representative.

16. Secure, from the Owner, private IP addresses for use by Ethernet equipped control system processors.

17. Ensuring that all cabling, equipment, and terminations are installed in accordance with accepted industry standards, approved shop drawings, manufacturer's recommendations and as stipulated herein.

18. Verify that all audiovisual equipment rack locations are provided with adequate clearance, ventilation and cable management systems to ensure all equipment is operating within manufacturer published tolerances.

19. Coordinating and providing cable labels as stipulated by the owner and/or specified herein.

20. Providing cable management hardware as required including in areas audiovisual rack cabinets; between pieces of equipment not housed in rack cabinets; and as required to extend cabling from rack cabinets and equipment to the greater facility cabling infrastructure.

21. Providing custom cover plates, wall plates, I/O connection plates, floor box insert plates as required for a complete and working system. Final selection of finishes shall be coordinated with the Architect and/or Owner.

22. Coordinating with the Consultant, Architect and Owner on the final selection of all technical furniture including design details (make/model), available options, dimensions, cable management needs, color, finish, and the like.

23. Provide all furniture and lectern hatch connector plates using industry standard AAP style or similar connectors or pass-thru openings. Provide mating or pull-out cabling for all furniture and lecterns to mate with user portable devices.

24. Coordinating with furniture manufacturer or others who are providing all necessary furniture/millwork modifications ("cut-outs" or other) as required allowing for a neat and professional installation of integrated technology system components. This includes, but is not limited to: integrated table/lectern "cubbies", table-top microphones, cable management grommets, etc.

25. Coordinating with the furniture manufacturer, Owner, and Architect on cable management needs and equipment installation requirements in all spaces so equipped and as outlined in 'Installation Practices'.

26. Conduct a wireless site survey within 30 days prior to substantial completion to determine available wireless frequencies for audiovisual equipment. Coordinate with local entities as necessary (manufacturer, Owner, SBE, FCC, etc.) to determine final channel selection for all wireless devices and resolve conflicts where they may occur.

27. Insuring that all equipment, with the exception of portable equipment, is firmly fastened or attached in place. A safety factor of at least Five shall be utilized for all brackets, fasteners and attachments. Provide safety retention cables for overhead equipment such as loudspeakers, projectors, etc.

28. Verifying and providing all projector lenses where required.

29. Providing all projector mounts, including guy wires, clamps, or support assemblies back to structural members. Obstructions vary from room to room; Contractor must pay close attention to this issue on a room-by-room basis.

30. Mounting / aligning the projectors so that digital keystone correction is not required. Optical lens shift shall be employed, only if necessary, to align the image with the image area. Where possible all projectors mounted below the ceiling shall be mounted and adjusted to be perpendicular to the screen surface.

31. Ensure that all systems have HDCP, EDID and resolution management profiles which are maintained from input through output/encode/display. Provide EDID management profiles to Owner's content provider 90 days prior to loading of initial content.

32. Coordinating with the Construction Manager on the audiovisual control system connection to the projection screens and lifts, as required.

33. Adjusting motorized projection screen limits as required optimizing the amount of black drop in conjunction with the projection system and field conditions. Refer to the drawings for specified dimensions.

34. Providing speakers as complete assemblies with back boxes, grilles, tile bridges, wall mounts, hanging hardware and other installation hardware as required.

35. Coordinating with the Architect and Owner on final color selection, and/or the painting of any exposed loudspeakers and any/all exposed system components to match the room's aesthetics and finishes.

36. Providing control system design submittals and up to two control system design revisions.

37. Developing and installing all custom control programming code as required and/or as specified herein.

38. Providing control system interfaces to motorized screens, as specified.

39. Providing low voltage control system interfaces to facility lighting and share systems where specified.

40. Coordinating and providing low voltage interfaces to the life safety platform for audio muting in all event and public assembly spaces.

41. Providing the executable (uncompiled) programming control code as defined herein.

42. Developing and installing all custom software for DSP devices as required to optimize system performance.

43. Generating and Submitting "Progress Reports" as defined herein.

44. Ensuring that all individual components function as intended by this Specification.

45. Ensuring that the entire multimedia systems function as intended by this Specification.

46. Providing any/all patching, caulking, fire stopping, and painting required to restore damaged finishes during installation.

47. Providing to the Owner, upon completion, all accessories and ancillary items included with the manufacturer's equipment but not used for the physical installation of the device. This shall include all user manuals, remote controls, batteries, tools, installation hardware, carrying cases, protective covers, etc.

48. Testing, adjusting, and fine-tuning the completed systems and components.

49. Coordinating and conducting acceptance walk-through and sign-off sessions with the Owner and Consultant.

50. Coordinating and conducting an acceptance walk-through and sign-off session with the Owner and Consultant.

51. Documenting the completed installed systems as defined herein.

52. Conducting training in systems operation for the Owner's designated representative(s).

53. Providing "sign-off" documents for each space and/or space type as defined in Section 3.6 "System Setup and Tuning" of this specification.

54. Verifying required cable lengths for all bulk cable or manufactured cable assemblies prior to ordering as outlined in 'Installation Practices.'

55. Verify AV related infrastructure requirements including conduit, power and data as shown on design drawings is sufficient to meet all AV systems requirements. A written report confirming infrastructure requirements is required from the Contractor within 30 days of award of bid.

56. Verifying all display mounting conditions including width, height and depth of all recesses or architectural cutouts required for displays and other flush mounted equipment.

57. Verifying the accuracy of the manufacturer master quotes where indicated on the audiovisual equipment list or other manufacturer quotation numbers prior to ordering. Where given, master quote numbers or other quotation numbers have been provided for bidding purposes only.

58. For all LED Video Wall systems

    a. Validate all power, cooling, weight, mounting, lead time, delivery and installation sequencing requirements within 30 days of award and communicating in a timely fashion any system parameters not in conformance with the current space design or project schedule.

    b. All video wall systems shall be HDMI 2.0 & HDCP 2.2 compliant. Contractor shall demonstrate the ability to show protected content in current formats as part of acceptance testing.

    c. Review the video processor and signal distribution requirements with the Owner's content provider to confirm conformance to the overall content package.

    d. For all LED Video Wall systems, provide a minimum of 5% spare panels onsite (measured after completion of burn-in, installation, commissioning and final-sign off). Provide an additional 5% spare panels housed at the manufacturer's site for use with break/fix repairs.

    e. Provide an extended warrantee of a minimum of 3 years for all parts and replacement hardware.

    f. Provide onsite manufacturer installation support services including during initial installation, calibration, acceptance testing and training.

59. Providing a minimum one (1)-year warranty service contract for all parts and labor. Where available from individual manufacturers, provide the consultant or preferred client extended warrantees.

60. Provide pricing for years two and three extended warrantees

61. Provide monthly preventative maintenance services for a minimum of (1) year.

62. Providing onsite support staffing as outlined in this Specification.

63. The Contractor shall act as the primary point of responsibility and contact in resolving all audiovisual system defects including those involving Owner Furnished Contractor Installed (OF/CI) equipment.

1.7 ALTERNATES

A. Provide pricing for alternates listed in the audiovisual systems equipment List accompanying this specification.

1.8 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Refer to AV Design Drawings as listed on drawing TA-000

C. Refer to AV Equipment list provided as part of this specification

1.9 RELATED WORK

A. Audiovisual Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for audio visual equipment and routing of audio, video, control, and power cables/raceway from equipment, terminal and pull boxes to system equipment racks.

B. Coordinate work of this section with installation of wall and ceiling finishes.

1.10 WORK EXCLUDED

A. Work not included under this contract shall be:

1. Providing conduit, power receptacles, junction boxes, cable raceways, electrical back-boxes, floor boxes, lighting fixtures, lighting dimming systems, or millwork except where otherwise specified herein.

2. Installation of wall or ceiling mounted projection screens.

3. With the exception of audiovisual network switches and interconnections as indicated in the audiovisual systems equipment list and system drawings the data and voice network is Provided by Others under separate contract for this building.

1.11 SCHEDULE

A. Project Milestones

1. The Contractor shall obtain from the Owner, Architect, Construction Manager or Consultant a project master timeline schedule showing projected dates when the relevant areas will be available to the Contractor for the on-site installation.

2. Within 15 days of notification of contract award, the Contractor shall provide a schedule of major project milestones to the Owner, Architect, and Consultant. The schedule shall show the following milestones, but may include others as required for overall site-work coordination:

a. Lead time schedule for all equipment

b. Shop Drawings and Submittals.

c. AV infrastructure validation

d. Required date for Owner meeting to review content

e. Required date for receipt of Owner furnished content

f. Delivery of materials to the work site for installation by Others.

g. Delivery of major system components to the work site.

h. Initial Touch Panel layouts

i. Completion of AV Equipment IP list for Owner coordination

j. Required date for receipt of Owner furnished equipment and PCs

k. Required network turn-on date for Audiovisual Connectivity

l. 50% completion of work by floor and by floor area.

m. 95% completion of work by floor and by floor area.

n. Completion of room run sheets (required prior to move-in).

o. Final punch list.

p. Training Sessions.

q. Submittal of Final Documentation / As-Builts.

3. The Contractor provided schedule shall outline a phased installation approach allowing time for installation, testing, issue remediation and sign-off on representative systems, spaces and programming prior to full scope deployment of systems.

4. If the Contractor feels that he/she will not be able to meet the scheduled project milestone deadlines, he must inform the Owner, Architect, and Consultant at the earliest possible opportunity and include in the notification a schedule catch-up or remediation plan.

1.12 JOB CONDITIONS

A. Coordination

1. In the interest of a coordinated and professional project, the Contractor shall:

a. Coordinate his/her work with that of other trades. The Contractor should anticipate attending weekly project coordination meetings with the Owner, Architect, Construction Manager, Consultant or other trades as required. These meetings shall be separate from weekly construction coordination meetings required by the General Contractor.

b. Afford other trades reasonable opportunity for installation work and for storage of materials.

c. Staff the job to keep pace with other trades.

d. Submit a brief progress report via e-mail to the Consultant, listing the following information in four sections: Schedule, Progress, Work Planned and Issues. The "Schedule" section shall list the status of all project milestones and track impacts to approved milestone dates. The “Progress” section shall list the tasks accomplished since the previous report; this is to include both completed tasks and work-in-progress. The “Work Planned” section shall list the tasks scheduled for the time period extending until the next report; this section should also include both completed tasks and work-in-progress. The “Issues” section shall list any factors that are delaying progress or have the potential to delay progress that involve the Owner, Architect and/or Consultant. The Progress Reports should be concise, utilizing bullet points or other efficient format. The Progress Reports should be submitted at the following intervals:

1). After contract award, while working off-site: every two weeks

2). While working on-site: every week.

e. After on-site work has started the Progress Report shall list the status of each room or space with audiovisual equipment and indicate the current status of items:

1). Cable Pull

2). Mount/Speaker/Backbox Installation

3). Room Ready

4). Display Installation

5). Furniture Installation

6). Rack Installation

7). Field Equipment Installation

8). Programming

9). Commissioning

10). Ready for Consultant Testing

11). Punch List Completion

1.13 SITE CONDITIONS

1. Reference drawings provided to the Contractor for bidding purposes may not reflect construction site as-built conditions. It shall be the responsibility of the Contractor to field-verify all site conditions relevant to his work.

2. The Contractor shall verify dimensions of equipment, equipment arrangements, space availability (including any millwork or cabinetry provided by others) and provide systems that work within the constraints of the space available. The Contractor shall notify the Consultant of any situation where space constraints are a problem, prior to the ordering or purchase of equipment. The Contractor shall bear the expense of providing alternate equipment, which will work within the available space, if space availability problems are discovered after equipment is ordered.

3. Drawings indicate locations of equipment and components. Changes in the location, and offsets of same to accommodate building conditions, and coordination with the work of other trades shall be made prior to initial installation, without additional cost to the Owner.

4. The Contractor shall insure during installation that access is provided to equipment and components requiring operation, service or maintenance within the life of the system.

5. It shall be the responsibility of the Contractor to identify any condition where the recommended environmental and/or electrical operating parameters for specified equipment/products cannot be assured. Should such condition exist, it shall further be the responsibility of the Contractor to notify the Architect and Consultant of any such condition.

1.14 LAWS AND REGULATIONS

A. All equipment, cabling, materials, and installation methodology shall conform to the requirements of the National Board of Fire Underwriters, the current published edition of the National Electrical Code, and all other applicable laws and regulations. The Contractor shall obtain and pay for any additional permits and inspections required by all legal authorities and agencies having jurisdiction over the Contractor’s work.

B. The Contractor shall comply with all of the legal regulations, including OSHA safety regulations and regulations of municipal, city, local, and other government agencies having jurisdiction concerning the work of the Contractor. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the work. If the Contractor performs any work which is contrary to such laws, ordinances, codes, rules and regulations, it shall make all changes to comply therewith and bear all costs arising therefrom.

C. The Contractor shall warrant that it and its subcontractors are licensed by the State and as required by local ordinances.

1.15 QUALITY ASSURANCE

A. All equipment for this installation will be new, less than one year from the date of manufacture, and without blemish or defect.

B. The Contractor shall maintain the same project manager and field supervisor throughout the installation, and where practical, maintain the same installers.

C. The Contractor shall supply and install any incidental equipment needed in order to result in a complete and operable system without claim for additional payment, even if such equipment is not listed in this Specification.

D. All work related to this Specification shall be completed in a professional manner by fully qualified workers.

1.16 RELIABILITY

A. General

1. The systems are designed to provide professional quality operation over a period of several years without the need for continual maintenance. Equipment that has a high failure rate is not acceptable for installation as part of these systems.

B. Warranty & Maintenance

1. The Contractor shall act as the primary point of responsibility and contact in resolving all audiovisual system defects including those involving Owner Furnished Contractor Installed (OF/CI) equipment.

2. The Bidder shall make known, in writing, at time of bid any exceptions that might exist between conditions described herein and Bidder's policy of warranty. After acceptance of bid, all conditions and requirements of warranty described herein shall apply.

a. The Contractor shall guarantee all equipment, materials, and labor for a period of 1 year from the date of final acceptance.

b. During the warranty period, within 4 hours of notification, the Contractor shall answer all service calls and requests for information.

c. During the warranty period, within 24 hours of original notification, the Contractor shall provide emergency service to restore operation of the system, replacing defective materials, repairing faulty workmanship, making temporary repairs, and providing loaner equipment as necessary, all at no charge.

d. The Contractor shall notify the Owner before any service call whether such call is or is not covered under warranty. The Owner may be billed for non-warranty calls. The Contractor shall notify the Owner of any service call or work to be performed for which charges may be incurred before such work commences.

e. Improper functioning, for warranty purposes, means failure of the system to meet the intentions of the specification because of internal defects. It does not include Owner caused malfunctions such as re-adjustment of the controls, re-tuning of the system, or injury to the system beyond normal wear. Nor does the warranty cover paint, exterior finishes, fuses, lamps (including projection lamps) or associated labor, unless the damage or failure results from defective materials or workmanship covered by the warranty.

f. The Contractor shall take such actions at the time of installation to insure that all equipment is installed in accordance with the manufacturer recommended environmental and electrical operating conditions and requirements. After installation, the Contractor shall be responsible for the repair or replacement of said equipment that the Contractor installs which fails due to environmental or electrical conditions, even if not covered by the manufacturer's warranty. The Contractor shall not be held responsible for damages due to changes in environmental conditions, which occur after system acceptance.

g. Unless otherwise directed, the Contractor shall activate all manufacturer warranties in the Owner's name. The start date of the warranties shall be the date of final acceptance.

h. If the Contractor has modified certain components, the manufacturer warranty may be void. In this case, the Contractor is responsible for providing warranty coverage equal to that of the manufacturer.

i. The Contractor shall perform (12) system maintenance sessions, one per month after substantial completion. Maintenance shall include a visual inspection, typical operation demonstration and addressing any issues noted on all systems. Contractor shall assume maintenance will be spread over multiple sessions to allow for scheduling around occupied spaces.

j. Certain subsystems and system components may require installation by authorized representatives in order for the complete manufacturer warranty to apply. If this pertains to any subsystem or component for this project, it is the Contractor's responsibility to make arrangements for the complete manufacturer warranty to apply. These arrangements are to be at no additional cost to the Owner.

k. As part of the bid response, the Contractor shall provide the Owner with a proposal to extend the Warranty to cover Year 2 and Year 3 of operation. These offerings are to include all parts and all labor; all conditions and restrictions listed above apply.

1.17 ALTERNATE EQUIPMENT

A. All bids shall be submitted based on the specified equipment. The Bidder may propose alternate equipment. However, all such proposals shall be submitted separately and will be identified as "alternates" with equipment costs shown separate and apart from the costs of the equipment "as specified".

B. Proposals for alternate equipment will receive careful and equitable consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Owner. All proposed alternate equipment shall work with the existing infrastructure.

C. All such proposals for alternate equipment shall be accompanied by full technical information, "cuts" and specifications for the equipment so proposed. The Bidder shall identify the substantive differences between the alternate and the specified equipment.

D. Owner and Consultant approval in writing is required before an alternate can be considered approved for use. It is at the discretion of the Owner and Consultant to determine if proposed alternates are considered acceptable and approved for this scope of work.

1.18 EXCEPTIONS AND PROPOSED MODIFICATIONS

A. Should the Bidder have recommendations, which will enhance the performance of the system, or reduce costs without loss of performance, reliability and durability, such recommendations shall be included with the bid submission. All suggestions that are of value to the Owner will be taken into consideration in the evaluation of the bid returns. All such proposals shall be made as "alternates", with the appropriate cost modifications shown separate and apart from the costs of the system "as specified". Pricing shall be on a line-item basis.

B. Any and all exceptions to these Specifications and related drawings must be made with the bid submission. In the absence of exceptions, these Specifications and related drawings shall be binding in letter and intent on the successful Bidder. It will further be assumed that the Bidder has examined the design and Specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.19 DEVIATIONS

A. For deviations in equipment or hardware after contract award, the Bidder shall provide a written statement describing why such deviations are requested. The Bidder shall also provide the manufacturer's specifications and warranty information on proposed substitutions. The Contractor shall be responsible for repaying any additional expenses incurred by other trades, the Consultant, the Architect, and/or the Owner, as a result of instituting such deviations without prior approval.

1.20 REVIEW AND INTERPRETATION DURING BIDDING

A. Notify the Architect and Consultant of any omissions, discrepancies or ambiguities in the documents so a clarification may be issued. Notify Architect, Owner and Consultant if exception is taken to any statement, indication or criterion in the contract documents.

B. Obtain all other contract documents, including architectural, structural, mechanical and electrical, and check to ensure there are no conflicts with work of this section. Notify the Architect and Consultant of all such conflicts, with any suggested alteration to resolve conflicts.

C. Submit all above notification in writing to the Architect and Consultant no less than 14 days prior to bid opening date. Lack of notification shall be understood to indicate acceptance of all requirements of the contract documents, and any future clams shall be rejected.

D. Interpretations or correction to the contract documents shall be issued by Addendum. Interpretations or corrections given by any other method shall not be binding.

PART 2 PRODUCTS

2.1 SYSTEM FUNCTIONAL DESCRIPTIONS

A. Guest Room

1. Shown for infrastructure coordination only, AV equipment supply and install by owner

B. Suite

1. Shown for infrastructure coordination only, AV equipment supply and install by owner

C. Main Lobby

1. AV Sources
    a. Background music (BGM) endpoint (by others)
2. Audio System
    a. Recessed ceiling speakers for program audio
    b. Amplifier with direct input form BGM system
3. Control
    a. All selection and volume controls will be within the BGM system
4. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

D. Fitness Center

1. Displays

a. Noted for infrastructure coordination only, display, mount, and CATV endpoint supply and install by owner

2. AV Sources

a. CATV endpoint (by others)

b. Background music (BGM) endpoint (by others)

3. Video System

a. Feed from CATV system (by others)

4. Audio System

a. Surface wall mounted speakers for program audio

b. Amplifier with direct input form BGM system

5. Control

a. TV control through manufacturer’s IR remote

b. Speaker volume controlled through a 70V wall volume controller

6. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

E. Private Dining

1. Displays

a. Utilizes one 86” LCD display

b. Pull out wall mount with integrated wall box

2. AV Sources

a. CATV endpoint (by others)

b. Background music (BGM) endpoint (by others)

c. Wired HDMI laptop input at wall location next to display

d. Wireless presentation gateway

3. Video System

a. AV source switcher

b. Digital AV extender for laptop input

c. Scaled digital AV extender for display output

4. Audio System

a. Recessed ceiling speakers for program audio

b. Amplifier sourced from the AV switcher

5. Conferencing

a. Audio conferencing support through a portable tabletop phone

6. Control

a. Control processor built into the AV switcher

b. Wall mounted control system touch panel

c. Touch panel layout, graphics, and function will meet Vassar standards

1). Touch panels should present users with an intuitive interface that guides its operation and leverages presets to automate functions

2). Touch panel example page layouts are to be submitted for approval

d. Control functions will include:

1). System power state

2). Source selection

3). Display power state based on source type

4). Volume up/down/mute

5). CATV tuner channel control

6). BGM channel control

7. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

F. Dining, Outdoor Dining & Bar

1. Displays

a. Noted for infrastructure coordination only, display, mount, and CATV endpoint supply and install by owner

2. AV Sources

a. CATV endpoint (by others)

b. Background music (BGM) endpoint (by others)

3. Video System

a. Feed from CATV system (by others)

4. Audio System

a. Recessed ceiling speakers for program audio in bar and dining areas

b. Surface ceiling mounted weatherized speakers for program audio in the outdoor dining area

c. Amplifiers sourced from the audio matrix

d. Audio from display is routed back to the audio matrix to allow its CATV source audio to be selected in the bar area

5. Control

a. Control processor built into the AV switcher in Private Dining system

b. Wall mounted control system button panel

c. Button panel layout, labels, and function will meet Vassar standards

1). Button panel example page layouts are to be submitted for approval

d. Control functions will include:

1). Display power state

2). Audio source selection for bar

3). Volume up/down/mute for each output zone

e. CATV tuner channel selection by manufacturer's IT remote

6. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

G. Pre-Function

1. AV Sources

a. Background music (BGM) endpoint (by others)

b. Audio announcements and overflow from Large Conference Room and Flexible Event Space

2. Video System

a. Ethernet cable pulled from AV rack to wall location for future use in NVX system

3. Audio System

a. Recessed ceiling speakers for program audio

b. Utilizes shared conferencing center audio DSP

4. Control

a. Utilizes shared conferencing center control processor

b. Wall mounted control system touch panel located in Director's Office

c. Touch panel layout, graphics, and function will meet Vassar standards

1). Touch panels should present users with an intuitive interface that guides its operation and leverages presets to automate functions

2). Touch panel example page layouts are to be submitted for approval

d. Control functions will include:

1). Audio source selection for bar

2). BGM channel control

3). Volume up/down/mute

4). Interpreter routing noted in Interpreter Connection section below

5). Audio routing noted in outdoor Event Space section below

5. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

H. Medium Conference Room

1. Displays

a. Utilizes One 86" LCD display

b. Pull out wall mount with integrated wall box

2. AV Sources

a. Two wired HDMI laptop inputs the conference table

b. Wireless presentation gateway

c. Owner furnished installed PC

d. Wall recess mounted PTZ camera below display

3. Video System

a. Utilizes shared conferencing center AV over IP switching system

b. Decoders are scaled for output to displays, USB converter, and CODEC inputs

c. Sources are switchable to either display, USB converter, and CODEC

4. Audio System

a. Recessed ceiling speakers for program audio

b. Utilizes shared conferencing center audio DSP with acoustic echo cancelation for conferencing

c. Beam forming ceiling microphone

5. Conferencing

a. Cameras and microphone noted above utilized for audio and video conferencing

b. Audio conferencing through DSP VoIP connection

c. Standards based video conferencing CODEC

d. USB converter for camera, presentation, and microphone signals to be used by the installed PC for software conferencing

6. Control

a. Utilizes shared conferencing center control processor

b. Wireless touch panel with wall mount charging station and table dock

c. Touch panel layout, graphics, and function will meet Vassar standards

1). Touch panels should present users with an intuitive interface that guides its operation and leverages presets to automate functions

2). Touch panel example page layouts are to be submitted for approval

d. Control functions will include:

1). System power state

2). Presentation source selection

3). Volume up/down/mute

4). Audio conferencing dialer and level controls

5). Video conferencing dialer and level controls

6). Camera pan, tilt and zoom controls with presets

7). System mode selection: presentation, audio conference, standard video conference, software conference

8). Interpreter routing noted in Interpreter Connection section below

7. Room Scheduling

a. One wall mounted touch panel mounted outside room entrance

1). Interfaces with existing Vassar College room scheduling system

2). Displays room schedule and allows room reservation at the panel

8. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

I. Large Conference Room

1. Configuration
    a. 2-way divisible space with identical sides
    b. Descriptions below note total equipment and functionality for combined system
2. Displays
    a. Utilizes two 86” LCD displays
    b. Pull out wall mounts with integrated wall boxes
    c. Utilizes two projector and 72.5” x 116” screen per side
    d. Ceiling recessed projector lifts
    e. Ceiling recessed electric screen with low voltage control interfaces
3. AV Sources
    a. Four AV over IP encoder for presentation sources at the reconfigurable tables
    b. Ten wired floor box connections for inputs to the AV over IP system
    c. Two wireless presentation gateways
    d. Two owner furnished installed PCs
    e. Two wall mounted PTZ cameras mounted at displays
    f. Two ceiling mounted PTZ cameras with inline video analytics functionality. The input from the analytics device with be automatically selected based on the selected function.
4. Video System
    a. Utilizes shared conferencing center AV over IP switching system
    b. Decoders are scaled for output to displays, USB converter, and CODEC inputs
    c. Sources are switchable to displays, projectors, USB converters, and CODECs
5. Audio System
    a. Recessed ceiling speakers for program audio
    b. Utilizes shared conferencing center audio DSP with acoustic echo cancelation for conferencing
    c. Four beam forming ceiling microphones
6. Conferencing
    a. Cameras and microphones noted above utilized for audio and video conferencing
    b. Audio conferencing through two DSP VoIP connections
    c. Standards-based video conferencing CODEC shared between both sides of Large Conference Room as well as both side of the Flexible Event Space

d. Two USB converter for camera, presentation, and microphone signals to be used by the installed PC for software conferencing

7. Control

a. Utilizes shared conferencing center control processor

b. Four wall mounted touch panels

c. Touch panel layout, graphics, and function will meet Vassar standards

1). Touch panels should present users with an intuitive interface that guides its operation and leverages presets to automate functions

2). Touch panel example page layouts are to be submitted for approval

d. Control functions will include:

1). Room configuration selection. When divided controls are local to the room side in which the panel is located. When combined all functions, sources and destinations are available at all touch panels.

2). System power state

3). Presentation source selection

4). Volume up/down/mute

5). Audio conferencing dialer and level controls

6). Video conferencing dialer and level controls

7). Camera automatic tracking over-ride and pan, tilt and zoom controls with presets

8). Camera analytics selection

9). System mode selection: presentation, audio conference, standard video conference, software conference

10). Routing noted in Broadcast Truck Connection section below

8. Room Scheduling

a. Two wall mounted touch panels mounted outside room entrances

1). Interfaces with existing Vassar College room scheduling system

2). Displays room schedule and allows room reservation at the panel

9. Mounting & Equipment Racks

a. Rack equipment will be mounted in AV/IT Rack Room 258

J. Flex Event Space

1. Configuration

a. 2-way divisible space, one projection based, the other utilizing an LCD display

b. Descriptions below note total equipment and functionality for combined system

2. Displays

a. Utilizes one 86” LCD display

b. Pull out wall mount with integrated wall box

c. Utilizes one projector and 72.5” x 116” screen

d. Ceiling recessed projector lift

e. Ceiling recessed electric screen with low voltage control interface

3. AV Sources

a. Four AV over IP encoder for presentation sources at the reconfigurable tables

b. Eight wired floor box connections for inputs to the AV over IP system

c. Two wireless presentation gateways

d. Two owner furnished installed PCs

e. Two wall mounted PTZ cameras mounted at displays

f. One ceiling mounted PTZ cameras with inline video analytics functionality available on projection side. The input from the analytics device with be automatically selected based on the selected function.

4. Video System

a. Utilizes shared conferencing center AV over IP switching system

b. Decoders are scaled for output to displays, USB converter, and CODEC inputs

c. Sources are switchable to display, projector, USB converters, and CODECs

5. Audio System

a. Recessed ceiling speakers for program audio

b. Utilizes shared conferencing center audio DSP with acoustic echo cancelation for conferencing

c. Two beam forming ceiling microphones

6. Conferencing

a. Cameras and microphones noted above utilized for audio and video conferencing

b. Audio conferencing through two DSP VoIP connections

c. Standards-based video conferencing CODEC shared between both sides of Large Conference Room as well as both side of the Flexible Event Space

d. Two USB converter for camera, presentation, and microphone signals to be used by the installed PC for software conferencing

7. Control

    a. Utilizes shared conferencing center control processor

    b. Two wall mounted touch panels

    c. Touch panel layout, graphics, and function will meet Vassar standards

        1). Touch panels should present users with an intuitive interface that guides its operation and leverages presets to automate functions

        2). Touch panel example page layouts are to be submitted for approval

    d. Control functions will include:

        1). Room configuration selection. When divided controls are local to the room side in which the panel is located. When combined all functions, sources and destinations are available at all touch panels.

        2). System power state

        3). Presentation source selection

        4). Volume up/down/mute

        5). Audio conferencing dialer and level controls

        6). Video conferencing dialer and level controls

        7). Camera automatic tracking over-ride and pan, tilt and zoom controls with presets

        8). Camera analytics selection

        9). System mode selection: presentation, audio conference, standard video conference, software conference

8. Room Scheduling

    a. Two wall mounted touch panels mounted outside room entrances

        1). Interfaces with existing Vassar College room scheduling system

        2). Displays room schedule and allows room reservation at the panel

9. Mounting & Equipment Racks

    a. Rack equipment will be mounted in AV/IT Rack Room 258

K. Broadcast Truck Connection

1. Video System

    a. Truck Dock patch location

        1). Ten (1) SDI Feeds

        2). Four (4) Dual LC Fiber Ties

3). 20 Audio Channel Feeds

4). Dual Channel Com Ties

5). Control LAN Connection

b. Two (2) SMPTE Hybrid Fiber wall plate connections at each side of the Large Conference Room with 4x8 SMPTE Hybrid patch bay in the AV Rack

c. Dual LC Fiber wall plate connections at each side of the Large Conference Room with 2x4 dual LC patch bay in the AV Rack

d. Rack mounted 6G SDI matrix router

e. Four AV over IP decoders to provide HDMI source content

f. Four (4) SDI inputs and outputs on a rack panel in the AV Rack

g. Connections to each Sony camera in the Large Conference Room

h. Two dry coax tie lines to each side of the Large Conference Room

i. Portable camera controller for Sony cameras

2. Audio System

a. Utilizes shared conferencing center audio DSP

b. Routable signals form program audio and all mics and mic inputs in the Large Conference Room

c. Tie line for two channels terminated for intercom to the Large Conference Room

d. Program audio for each side of the Large Conference Room routed to the wall plate in the corresponding side

3. Control

a. Controlled at wall mounted touch panel in Director’s Office

b. Control functions will include:

1). The active program audio source for each side of the Large Conference Room will always route to the PRGM L/R jack on the wall plates and associate truck rack jacks. When the room is combined, the same source will be routed to both.

2). Full routing of AV over IP video sources in the Large Conference Room to the 6G-SDI router, defaulting with presentation content

3). Full routing of audio from the Large Conference Room to the Truck Dock Plate including ceiling microphones, wireless microphones, wired mic jacks, and program audio.

4). The interpreted language feed for each side of the Large Conference Room will always route to the associated INTERPRET jack in the track rack. When the room is combined, the same source will be routed to both. If two languages are being interpreted, one will be on each jack regardless of room combine state.

c. Connection to the AV control LAN for connecting the Sony camera controller

4. Mounting & Equipment Racks

a. Wall box connection points in each side of the Large Conference Room

b. A patch panel in an outdoor, weatherproof box at the loading dock

c. 6G-SDI router and patch panels mounted in the shared AV Rack

L. Interpreter Connection

1. Video System

a. Utilizes shared conferencing center AV over IP switching system

b. Decoder to provide HDMI output for an owner furnished monitor to display the camera feed in the selected room

2. Audio System

a. Utilizes shared conferencing center audio DSP

b. Dante endpoint

1). Provides an audio output of the presenter in the selected room to an owner furnished interpreter station

2). Provides an audio input from the owner furnished interpreter station to feed the truck connection

3. Control

a. Controlled at wall mounted touch panel in Director's Office

b. Control functions will include:

1). Selection of room source for NVX and Dante signal pair for each of two interpreter stations. Routes are independent as one interpreter language may be in the Medium Conference Room while the other is in the Director's Office

4. Mounting & Equipment Racks

a. Components mounted in portable racks, one for each language

2.2 EQUIPMENT

A. Refer to the attached AV SYSTEMS EQUIPEMENT LIST Rev1- VASSAR for the following:

1. Type and quantity of spaces with audiovisual systems

2. Description and quantities of audiovisual equipment within each space

3. Notes detailing special audiovisual equipment considerations or coordination requirements

4. List of existing Owner furnished equipment

B. New Owner Furnished Equipment

1. Contractor shall take receipt of all new Owner furnished computers, codecs and CATV receivers at the project site and install as indicated in Audiovisual drawing package system flow diagrams.

PART 3 EXECUTION

3.1 SUBMITTALS

A. General

1. The Contractor shall maintain a master set of this entire Specification, including all drawings and addenda, at the site at all times during the installation. Any deviations from the Specification made during the installation shall be marked on this master set. The master set along with all relevant support documentation shall be provided as part of the As Built submittal in the format outlined under Final Documentation.

B. Software

1. The Contractor shall secure from the Owner or Owner's Representative, in writing, approval for all control system graphical user interface layouts (control surfaces), audio DSP device configurations, or other customized software product applications prior to installation.

2. Preliminary Control Surfaces Submittal

a. Prior to creation of the preliminary control surface submittal the Contractor shall coordinate a meeting among Contractor, Consultant and Owner to discuss overall programming intent and specific requirements or concerns that the Owners or consultant has related to the control surface look, operation and capabilities.

b. The intent of the preliminary control surfaces submittal is to create a base level collaboration tool whereby the contractor can solicit direction from the Owner and Consultant towards a mutually agreeable design. Based upon the equipment lists and control system functionality provided in the Audiovisual Systems Specification and in combination with the system topology illustrated on the signal flow drawings, the Contractor shall generate preliminary control surface layouts for all pushbutton panels, touch sensitive panels, PC based controllers or other control surfaces. The Contractor should endeavor to make the preliminary layouts as complete as possible. The layouts should illustrate all pushbuttons, labels, bar graphs, timers, video windows, etc. for each control panel and each system page. The Contractor should include suggestions for color schemes and graphics where applicable.

c. It is recommended that control touch panel layouts conform to the InfoComm Dashboard for Controls Design Guide. This design guide is available on the InfoComm website at http://www.infocomm.org.

d. The contractor shall receive written response indicating approval to proceed, or changes required to the control surfaces layouts, within 10 working days of receipt of the submittal by the Owner/Consultant.

3. Revised Preliminary Control Surfaces Submittal

a. If changes are required to the preliminary control surfaces submittal, the contractor shall generate a revised preliminary control surfaces submittal to include the additions, changes or revisions generated by the preliminary submittal review. The form and quantity of the submittal shall be identical to the preliminary submittal unless otherwise directed. If the revised control surfaces submittal reflects those additions, changes or

revisions called for in the preliminary submittal review, the contractor shall receive written approval to proceed within 10 working days of receipt of the submittal by the Owner/Consultant.

b. The Contractor shall respond with the updated control surface submittal capturing all required changes indicated in the Owner/Consultant response within 10 working days of receipt of the response.

c. A minimum of two control surface revisions shall be provided.

4. Post-Integration Adjustments

a. If so requested by the Owner or Consultant, and within 90 days of system acceptance as outlined in 'System Acceptance', the Contractor shall be prepared to make two visits to the site to make final adjustments to the control system code or programming without additional compensation. This could include, but may not be limited to, renaming or changing the size or location of buttons, page flip calls, or adjustments to code to provide a fully functioning system. If engraved control system panels require modification at a cost to the Owner, such cost information must be submitted to the Owner for approval prior to any work being performed.

b. The Contractor shall be responsible for insuring that any changes to the control system or control surfaces that occur post integration are appended to the Final System Documentation.

C. Shop Drawings

1. The Contractor must receive written approval from the Owner prior to fabricating or installing any materials. Approval will be given based upon shop drawings. The shop drawings shall indicate complete details of work to be performed. The Contractor shall submit electronic copies of shop drawings to the Owner and Consultant for review and approval. Drawings shall include a title block naming the project, Owner and Consultant, and, shall include a drawing title, drawing number, revision number if applicable and date.

2. The shop drawings listed below are required of the Contractor. Provide electronic files and up to (1) paper set if requested by Owner or Consultant. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior written approval.

a. Audiovisual Cut Sheets, sorted by space type with an overall equipment list identifying quantities, manufacturer, model and all accessories

1). Where multiple options or models are shown on a cut sheet, the project specific option or model shall be highlighted.

2). Equipment color options shall be highlighted for Architect confirmation with returned submittal.

3). Cut sheets shall NOT include installation manuals or manufacturer overall product line brochures.

b. Facility drawings, based on the Consultant's drawings, an updated set of floor plans, elevations and RCPs identifying all equipment locations, supporting infrastructure and cabling requirements.

c. System Signal Flow: Complete functional system signal flow of all systems described herein and meeting the functions indicated in the Specification.

d. Cabling Schedule: A list containing the cable type, cable marker identifier, and origination and destination location and connector types for each cable.

e. Examples representative of the Contractor's final cable marking technique for each cable type.

f. Loudspeaker Mounting Details: Scaled drawings of complete loudspeaker mounting details, hardware and support surfaces, including details on all load requirements, safety factors, safety cables and structural materials.

g. Projector Mounting Details: Scaled drawings of complete projector mounting details, hardware and support surfaces, including details on all load requirements, safety factors, and structural materials.

h. Structural Anchorage: Provide structural calculations, drawings and details for the anchorage of equipment racks, loudspeaker rigging hardware, the projector rail-mount system, and all other mounts or hardware that attach to structure. The design shall be reviewed and approved by a Structural Engineer licensed in the project state.

i. Optical Systems: Scaled drawings to verify that the proposed projection devices, lenses and related optical systems will provide the desired image size. The Contractor shall be responsible for field verification of the on-site conditions if required.

j. Panels: Scaled drawings of interconnect panels, control surfaces, and other custom interfaces.

k. Peripheral Equipment: Scaled drawings of mounting arrangements of any peripheral equipment, which may be included in this Specification.

l. Equipment Rack Layouts: Fully detailed rack drawings indicating equipment orientation within the equipment rack.

m. Technical Furniture: Scaled drawings of all technical furniture indicating dimensions, materials, finishes, equipment locations and orientation, cable management accommodations, and all other details necessary to convey the physical and functional aspects of the furniture.

n. Others, as may be required by the Architect, Consultant or Owner.

D. Labels / Wire Markers

1. Except where otherwise indicated, all rack-mounted equipment, switches, controls, and interface panels shall be clearly labeled.

a. Panels and plates shall be a minimum 1/8" thick anodized aluminum etched and epoxy filled unless otherwise specified.

b. Rack mounted equipment shall be labeled with engraved and filled plastic laminate. Where appropriate, the function of, or the input, output, or loudspeaker(s), served by each device shall be indicated. Other methods of labeling rack mounted equipment may be accepted pending prior written approval by Owner.

c. All cables shall be permanently identified at each end by machine printed cable markers and protected by the appropriate size clear shrink tubing. Every cable shall have a unique tag number identifier for each cable. The Contractor shall include this unique tag number on the As-Built signal flow documentation. Each cable marker shall include, in addition to the unique tag number identifier, the name of the origination and destination equipment termination at each cable end (see example below). Cable markers shall be placed two (2) inches from where the cable exits the strain relief of the connector, but never within a cable bundle.

2. Identification Panel

a. An identification panel shall be installed within the equipment rack including Contractor and Consultant contact information. The panel shall be mounted in the top rack space.

3.2 CONTROL SYSTEM REQUIREMENTS

A. Control System User Interface

1. All panels are to have the time and date as icons, in the same position on every page.

2. All panels are to have a title, indicating the piece of equipment and/or functionality being controlled.

3. When a portable device is connected to the system while powered down the system shall be programmed to automatically wake and switch to the active input. Touch panels shall activate and switch to the local presentation page reflecting the active input used.

4. No individual component shall be programmed to function atypically.

5. Devices similar in nature shall be programmed to operate with a common format.

6. Pages for source equipment shall conform to the following guidelines:

   a. Transport controls should be on the main device page.

   b. The primary transport controls, <Play>, <Stop> and <Pause> should be larger than the other transport controls.

   c. Buttons shall include both graphic images and text.

   d. A button shall be included for a pathway to device specific controls, including menus and advanced device functions.

   e. A button shall be included for a pathway to recording functionality. This shall include a single-bus control for the recording source.

7. Final programming shall include capability to remotely control all functions of the audiovisual system. Individual device controls shall provide full manufacturer's functionality.

8. Provide control capability for every function available on every piece of equipment being controlled by the system. Define and provide "macro" commands for the most used functions.

9. Provide control panel layouts that are consistent from page to page. Whenever the same button appears on more than one page, it will be in the same position on each page.

10. Functions used during a general presentation shall be accessible with a minimal amount of button presses/page flips.

11. All power functions, or other destructive commands, activated by the users through the user interface shall be intercepted in the programming. The user shall be provided with the opportunity to cancel out the command prior to any actions being initiated and without disturbing the current operating model.

12. Where feasible, multi-level access to controls should be implemented. All software shall provide multiple levels of password protection. Initially three levels of security will be established and specific rights to program areas shall be assigned by user:

    a. Level 1 shall allow user to operate the system, without a password. Control shall be limited to basic functionality directly affecting the space in which the control is located.

b. Level 2 shall be password protected, and allow user to modify system parameters and features listed in level 1.

c. Level 3 shall be password protected, and allow a technician access to set-up functions, source selection, etc.

B. Control System Hardware

1. Provide remote control of systems with an integrated master controller, which provides ports for IR/serial, RS-232/422/485, Ethernet, relay closures and input and output control card frames and rack mounted, of all dedicated audiovisual components.

2. Unless where specified as Owner Furnished, provide all required network equipment, including, but not limited to, routers, hubs, gateways, media converters, etc., for integration of the networked AV Control system with the Owner's existing LAN and control system.

3. When a choice of control protocols is available for a piece of equipment, the most secure and flexible one shall be used; i.e. RS-232 control, where available, shall be used in place of either infra-red or relay control.

4. All equipment utilizing a "toggled" power command are not to be powered on and off from the control system.

C. Additional Control System Surfaces

1. Port all completed touch panel interfaces to web browser based control.

2. Port all completed touch panel interfaces to be fully mobile device compatible on Apple iOS or Android™ mobile devices.

3.3 INSTALLATION PRACTICES

A. General

1. All equipment shall be installed in accordance with this Specification, approved shop drawings, and manufacturer's recommendations.

2. All equipment with the exception of portable equipment shall be firmly fastened or attached in place. A safety factor of at least five or a published safe working limit shall be utilized for all brackets, fasteners and attachments. Provide safety retention cables for overhead equipment such as loudspeakers, projectors, etc.

3. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

4. The Contractor shall insure that all equipment is installed such that proper cooling and ventilation is insured.

5. All equipment shall be installed in a manner which prevents hum, RF/EMI/EMF interference, and mechanical vibration based noises (e.g. fan mounts, etc.)

6. Projectors, lenses, and mirrors shall be solidly mounted and braced so that there will be no observable movement in the image induced by motor vibration or other mechanical operations.

7. All equipment shall be protected from construction dust and debris until final acceptance of the system.

8. All equipment shall be protected from theft until final acceptance of the system.

9. Any equipment designed for use by end-users in the facilities must be installed with theft deterrence/protection mountings and fasteners. Any tools required to mount/un-mount this equipment must be furnished to the Owner at the date of Owner acceptance.

10. The Contractor shall be obligated to protect completed work and uncompleted work against damage or loss until the Owner has given final acceptance. Should the need arise to repair work or replace items the Contractor shall do so at no cost to the Owner.

B. Furniture

1. The Contractor shall ensure that equipment or mounting hardware is compatible with and suitable for installation in furniture specified by the Architect, Consultant, or furniture supplier. It shall further be the Contractor's responsibility to ensure that such coordination with the Architect, Consultant, or furniture supplier occurs.

2. The Contractor shall exchange with and follow such shop drawings as to ensure that dimensions and structural supports are adequate for the installation of specified equipment. It is the Contractor's responsibility that the request and delivery of such critical coordination information is satisfactorily executed. In as much as the Contractor has control over the delivery of such information, it shall deliver it as requested by the Architect, Consultant, or furniture supplier.

C. Equipment Racks and Equipment Rack Cable Management

1. Racks shall be installed in such a way so as to permit access to all equipment for service.

2. Racks are considered complete components and should be completely assembled and tested at the Contractors facility prior to onsite installation.

3. All equipment in racks shall be fitted with vent panels and/or fans as required to provide ventilation and cooling according to equipment manufacturer's recommendations.

4. Adjacent racks shall be bolted together with appropriate ganging hardware.

5. As a general practice, all power cables, control cables, and high-level cables shall be dressed to the left rear of an equipment rack. Audio and video cables shall be dressed to the right rear of the rack. Audio, video and control cables shall be bundled separately and spaced not less than three (3) inches apart.

6. Internal equipment rack cabling shall be supported by lacing strips, support brackets, or other cable management systems as required to ensure that all cabling is supported in both the vertical and horizontal planes within the rack.

7. With the exception of ganged equipment rack assemblies, cabling routed between equipment racks or pieces of equipment exterior to equipment racks, or extending to the greater facility cabling infrastructure, shall be completely protected, end-to-end, by a raceway, wire-way, or duct appropriately sized for the cable run.

8. Cabling between rolling pieces of equipment not housed in rack cabinets or a rolling equipment rack and any device to which it is connected, shall be protected by a split-loom corrugated tubing wrap or other such flexible cable management system appropriately sized for the cable run.

9. Any controls not to be adjusted by the user and accessible from the front of the equipment rack must be furnished with security panels.

3.4 CABLING

A. CABLING TYPES

1. Refer to the Audiovisual drawing package for minimum audiovisual low-voltage cabling requirements.

2. Coordinate UTP and Fiber Optic cable types with Information Technology (IT) requirements and submit UTP cable for approval by Owner and Consultant.

B. CABLE INSTALLATION

1. Non-contiguous cable support mechanisms such as hangers, rings, and hooks shall not be spaced farther than four (4) feet apart. All manufactured raceways used for cables shall be installed according to the raceway manufacturer's specifications

2. Cable runs shall be supported with devices designed for this purpose and are to be installed independent of any other structural component.

3. Cables routed vertically up walls, or between floors as vertical riser, shall be supported with clamps or other mechanisms. These supports shall occur at least three times per floor.

4. The Contractor shall maintain, or where not already existing, provide through penetration fire stop systems to prevent the spread of fire through openings made in fire-rated walls or floors to accommodate penetrating items such as conduit, cables or other pathway. Fire stop shall restore floor and wall to the original fire rated integrity and shall be waterproof. The fire stop systems and products shall have been tested in accordance with the procedures of U.L. and material shall be U.L. classified as materials for use in through-penetration fire stops.

5. The fire stop system shall comply with the NEC and with NFPA 101-Life Safety Code (latest edition) and shall be made available for inspection by the local inspection authorities prior to cable system acceptance. The contractor shall be responsible for verifying the fire rating of all walls and floors affected by his work.

6. Cable pulling tension may not exceed manufacturer recommendations. Where cable-pulling lubricant is used, the lubricant must be compatible (non-damaging) with the conduit and cable sleeve materials and must not harden over time to prevent future pulls.

7. Cable stapling of any recognized media type shall not be permitted.

8. Cables shall be dressed in conveniently sized bundles and either laced or banded. Lacing or banding shall not be so tight as to deform cable bundles.

9. Cabling installed with a bend radius less than that recommended by the cabling manufacturer is not acceptable.

10. Cables and bundles terminating at equipment or connector panels shall be supported so as not to put strain on connections or connectors.

11. All cables, with the exception of video or pulse cables, which must be cut to an electrical length, shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes without prior approval of the Consultant.

12. Cabling for equipment mounted in drawers or on slides shall be provided with a service loop of appropriate length. A cable management support for the service loop shall be provided to prevent the service loop travel from interfering with the operation of the drawer or slide, or snagging on adjacent cabling.

13. Where indicated on the Audiovisual Drawing Set microphone level, line level, loudspeaker level, and video lines shall be run in separate conduits, trough, raceway divider, and cable bundles. Low voltage DC and control may be run along with any signal types other than microphone or line level runs.

C. TERMINATION

1. All termination components must meet or exceed all specifications for given media type and application as described in this document and system drawings.

2. Crimp on connectors shall be installed only on the appropriate size cable using the manufacturer recommended crimp tool and die set.

3. Connections to electronic devices providing screw terminals shall be terminated using the appropriate gauge insulated spade or ring crimp terminal connector and crimp tool.

4. All mechanical solder-on connectors shall be attached to cable ends using rosin core solder.

5. Audio signal cable shields shall be protected with the appropriate gauge Teflon or heat-shrinkable tubing. The jacket end of each audio cable shall be fitted with the appropriate gauge heat shrinkable tubing to provide additional protection to the base of the shield or shield foil. This also applies to the inside of mechanical connectors and cables that terminate at partitioned barrier strips.

D. AV Over UTP Cabling System

1. In some areas, analog video, audio, and control signals will be transmitted over a dedicated system of unshielded twisted pair (UTP) cabling utilizing specialized electronics. UTP transceivers located in the presentation spaces will connect to similar devices in the equipment racks via a cabling scheme comprised of RJ-45 receptacles, permanently installed cabling, equipment cords, and patch cords and patch panels.

2. Each AV over UTP port receptacle, permanently installed cable, equipment cord, patch cord and patch panel will be of a color or have markings that are non-standard with the voice/data system, and be plainly and permanently labeled (AV ONLY - NOT DATA).

3. To eliminate the problem of skew caused by the varying pair lengths inherent with CAT-5e/6 UTP cabling, a specialized skew-free UTP bulk cable, patch cables, and equipment cords are specified.

4. The Contractor shall test, verify and document the length and wire map of each Permanent Link cable run, each patch panel to transceiver cable segment, and each patch and equipment cord using a Fluke model 620 LAN Cable Meter or equivalent.

E. Grounding

1. General

a. To avoid system noise, data errors, safety hazards, and equipment damage, all devices and cabling shall be installed using a consistent grounding scheme. All devices shall be grounded and all ground conductors shall follow a star topology. The grounding system topology should be such that each equipment rack and each piece of signal bearing equipment is connected so that there is never more than a single path to ground. This section offers guidelines for grounding and shielding methodology. Grounding and shielding methodology may need to be augmented or modified for certain pieces of equipment or interconnections in order to meet the requirements of other sections of this specification. The Contractor shall be responsible for making necessary alterations in accordance with industry practices and such that the Performance Standards detailed in ‘Performance Standards’ are met.

b. Under no circumstances shall an AC neutral conductor be used to ground equipment.

c. Refer to the International Communications Industries Association, Inc. (InfoComm International) Basics of Audio and Visual Systems Design handbook, Section 10, Technical Power and Grounding Systems for additional guidelines.

2. Interconnection

   a. All connectors used on system I/O panels shall be electrically isolated from the panel and provide a pass through (uninterrupted) ground connection.

   b. Microphone cable shields shall be connected to the microphone frame and grounded only at the preamplifier input connector.

   c. All audio interconnections with cable lengths greater than 10 feet shall use balanced (symmetrical) signaling.

   d. All audio signal cable shields shall be grounded only at the input connection of each device. Signal cable shields, both connected to devices and floating, shall be protected by the appropriate gauge heat shrinkable tubing. Shields at the output connector shall be folded back over the cable jacket and covered with heat-shrinkable tubing. Do not cut off unused shields.

   e. Coaxial video and RF shields shall be connected at both ends.

3. Pull Strings

   a. A nylon pull string shall be left in every conduit. In the event additional cables are pulled in after the initial cable pull, a nylon pull string shall be pulled with the added cable.

3.5 PERFORMANCE STANDARDS

A. Audio

1. Polarity

   a. Absolute signal polarity will be maintained throughout the signal chain such that a positive signal at the input produces a corresponding positive excursion at the loudspeakers.

2. Electronics

   a. The audio system electronics shall deliver the following minimum performance standards as measured from all source inputs for microphones, audio tape machines, video tape machines, etc., through all mixers, audio distribution amplifiers, routers, etc., to all audio signal destinations.

   b. Frequency Response: ±0.5dB, 20-20,000 Hz.

   c. Hum and Noise: -70 dBu, 20-20,000 Hz, un-weighted.

   d. Distortion: 0.1% THD, 20-20,000 Hz

3. Speech Signal

   a. (a) The system shall provide a speech signal in the audience seating area that meets or exceeds the following requirements:

      1). Frequency response within +/- 3 dB from 500 Hz to 15,000 Hz.

      2). Overall SPL variance of +/- 3 dB.

      3). Measured Alcons of 10% or lower.

      4). Maximum average SPL of 85 dB (flat), with 10 dB of undistorted headroom available.

4. Music Signal

a. The system shall provide a music signal in the audience seating area that meets or exceeds the following requirements:

1). Frequency response within +/- 3 dB from 200 Hz to 17,000 Hz.

2). Overall SPL variance of +/- 3 dB.

3). Maximum average SPL of 90 dB (flat), with 10 dB of undistorted headroom available.

B. Optical

1. All video projection systems shall meet the following performance standards:

a. The total averaged light output from a video projector, in ANSI lumens, shall be tested by the Contractor and certified to be within ±15% of that specified by the projector manufacturer.

b. All video projection systems shall be measured by the Contractor using ANSI/INFOCOMM 3M-2011 Projected Image System Contrast Ratio and documented for Owner and Consultant review.

3.6 SYSTEM SETUP AND TUNING

A. Optimization

1. The Contractor shall install, configure, adjust, program, and calibrate all components in order to optimize the performance of all individual subsystems and the system as a whole.

B. Preliminary Tests and Submittals

1. General

a. Once the system is installed, the Contractor shall complete the following preliminary tests and prepare a written test report for the Owner and Consultant. The test report will list the results of each of the tests described in this section and certify that the installation is complete

2. Testing Format and Requirements

a. Sign-off documentation format will be provided to the contractor in advance of initial shop testing and will follow the ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification standard format.

b. A full ANSI/INFOCOMM 10:2013 review and validation of one (1) example of each system type documented by the Contractor will be required.

c. Subsequent system type reviews will include overall capabilities evaluations. Noted punch list items will be referenced to their ANSI/INFOCOMM 10:2013 equivalent.

d. Where significant defects are noted in the subsequent system type reviews, the Owner and Consultant may elect to require Contractor to document to the full ANSI/INFOCOMM 10:2013 standard and remedy all deficiencies noted.

3.7 FINAL TESTS

A. Upon approval of the Contractor's test report, and at a time that is mutually acceptable to the Contractor Owner and Consultant, the Contractor shall assist the Consultant in final system tests and adjustments. The Contractor's representatives assisting in the performance of these tests shall be thoroughly familiar with the details of the system and shall include the field supervisor responsible for installing the system.

B. To demonstrate the good working order of all playback devices in the system the Contractor shall make available high quality source materials for all audio and video media types represented in the system. To demonstrate the good working order of all computer-video displays the Contractor shall make available the computer-video signal generator described in 'Performance Standards - Preliminary Tests and Submittals - Computer Video Display Devices'. In addition, the Contractor shall make available a computer graphics signal generator or portable computer with the ability to output all video formats natively supported by the audiovisual system specified. The portable computer shall be capable of displaying spreadsheets, graphs, charts, pictures and text of varying sizes and fonts to effectively demonstrate the systems computer display imaging capabilities.

C. The Contractor shall:

1. Load source material into all input sources and the laptop computer.

2. Switch randomly between all sources and demonstrate that all functions of the control system are working properly and tracking correctly.

3. Demonstrate that the displays have been optimized for all sources.

4. Demonstrate that the system meets the criteria as outlined in 'Performance Standards'.

3.8 FINAL DOCUMENTATION

A. Upon completion of the work, the Contractor shall condense the master set along with any shop drawings into a single As Built document set. Any markings or deviations, which cannot be made clear on drawings, shall be accompanied by attached documentation, photos, or written addenda.

B. All documents and drawings must be submitted electronically in their native AutoCad and PDF format. Further, all PDF drawings must be submitted at their native scale. For example, a PDF created from a drawing whose native format was standard 'E' size (42-inch x 30-inch) shall be created at 42-inch x 30-inch (full size) to insure that there is no loss of resolution should the file be viewed or printed at a later date by the Owner.

C. Final submission of digital As Built drawings files shall be subject to submission by the Contractor as defined under said agreement.

1. Preliminary Final Documentation Submittal

a. Prior to Final Tests and project punch-listing, the Contractor shall prepare and submit one (1) copy of the documentation listed below to the Consultant and owner for review. The package shall include all of the documentation listed below and be in the exact form and format intended for delivery to the Owner.

b. The documentation shall be in electronic format AutoCad and PDF file format copies and organized as follows:

1). A cover and spine listing the Owner, Consultant, and Contractor.

2). A listing of each supplied item with manufacturer, model number and serial number.

3). Operator's manuals for each piece of equipment supplied by the Contractor.

4). A complete set of as-built drawings. The as-built drawings must reflect all changes to the system(s) made after the original bid documentation. The size of the as-built drawings shall be identical to the original drawings provided to Contractor, folded and inserted into the binders in plastic sleeves. Alternative formats may be acceptable upon prior approval by the Consultant and Owner.

2. Final Documentation Submittal

   a. Following successful completion of Final Tests and punch-listing, the Contractor shall prepare and submit to the Consultant and Owner electronic copies of the documentation listed under the Preliminary Final Documentation Submittal. The Final Documentation Submittal will include any and all adjustments or changes identified during the Preliminary Final Documentation Submittal review.

   b. The documentation shall contain PDF file-format copies for items 1 through 4 in Section A above and include detailed digital photographs showing the front views of all equipment racks. The photographs shall accurately reflect equipment front-panel settings at the time of project sign-off. All photographs must be properly exposed and focused, clearly showing the final settings for every device's push buttons, rotary controls, slider controls, or indicators. Subject areas must be free from glare as a result of flashes or other ambient lighting. Subject areas shall fill the image frame in a suitable manner. For large equipment racks, multiple exposures may be required, each indicating a separate portion of the rack. NOTE: All digital images shall be comprised of at least 1600 x 1200 viewable pixels, 24-bit color depth, JPEG file format.

3. Software

   a. Where custom software is developed as part of this project, the system source code and any associated related files, referenced files, and development software (and all relevant documentation and license) used to compile, develop, and build, etc. the executable code must be provided to the Owner only. The source code should be well documented in accordance with industry software engineering practices.

   b. The software developer shall retain intellectual property rights; the Owner shall have a license for perpetuity for use as it applies solely to this project, including the right to modify/enhance. The software code may not be sold or used, in part or in whole, in any other project or application other than that intended by this specification, in part or in whole, by the Owner or any other party.

   c. If a Subcontractor is used to write the software, the Contractor shall include, as part of the Final Documentation submittal, a signed letter on Subcontractor letterhead, granting the Owner ownership, use, and modification rights of the code and documentation as defined herein. The software shall be provided to the Owner as part of the Final Document Submittal.

   d. Copies of all manufacturer software required to program, compile, load and adjust audiovisual hardware settings or programming shall be provided.

   e. Copies of the current firmware and/or hotfix versions for all equipment with programmable firmware.

4. Delivery & Approval

   a. Unless otherwise arranged, The Contractor shall prepare and submit one complete set of the Final Documentation to the Consultant for review at the time of Final Tests. The package shall include all of the documentation listed above and be in the exact form and format intended for delivery to the Owner.

b. If the Final Documentation submittal is determined by the Consultant to be complete and accurate, the Consultant will approve the submittal and forward the Final Documentation package to the Owner.

c. If the Final Documentation submittal is determined by the Consultant and/or Owner to not be complete and/or accurate, the Consultant will return the package to the Contractor with a written listing of the required modifications. Upon completion of all of the required modifications, the Contractor shall resubmit the Final Documentation to the Consultant and Owner for approval. The Final Documentation submittal shall not be considered to be complete until all required modifications have been made and approved by the Consultant and Owner.

3.9 TRAINING

A. The Contractor shall provide a minimum of (40) hours of on-site training for (but not limited to) the Owner's staff at a time that is mutually agreeable for the Owner and Contractor.

B. The Contractor shall provide an additional minimum of (10) hours of content system initial template layouts, training and configuration.

C. Contractor shall provide (2) additional day(s) for system walk thus etc. at the request of the Owner and/or Consultant.

D. The Owner may choose to have the sessions spread out over a period of time and vary the staff being trained and the level of training. Final acceptance and/or final payment for the system shall not be delayed due to scheduling delays beyond the control of the Contractor. Contractor, should also be available for requested additional training.

E. As part of user training Contractor shall provide single page laminated room use cards for all rooms and tailored to each specific room type. Room card shall include:

1. Simple instructions for basic user functions (system on, off, media, making VTC & ATC calls).

2. Help desk contact information.

3. Room type capabilities (presentation, VTC, ATC, etc.)

4. Electronic version of the room use cards shall be provided to the Owner two weeks prior to move-in to allow for Owner formatting and review.

3.10 ONSITE SUPPORT STAFF

1. For the period of 30 days the Contractor shall provide (1) staff member onsite week days from 9am to 5pm to help support Owner move-in, administrative staff training, ongoing system troubleshooting and adjustment.

2. The staff member provided shall be familiar with the installation and operation of the system specified and shall have been onsite with the installation team at least two weeks prior to Owner move-in.

3.11 SYSTEM ACCEPTANCE

A. Upon successful completion of Final Tests, Documentation and Training, the Contractor shall notify the Owner, in writing, that the system is complete which notification shall be accompanied by consultant's continuation of completion. The Owner shall have fifteen (15) days to generate a punch list of omissions, adjustments, corrections and the like and respond in writing to the Contractor. In the absence of such a Punch List, the system shall be considered to be complete. The warranty shall commence on the day after Owner shall have conformed, in waiting, that the

work has been completed in accordance with the requirements of the contract documents or, if Owner fails to provide such written confirmation, or the Punch list, within each fifteen (15) day period, on the fifteen day after the Contractor's notification of completion of work (accompanied by consultant's confirmation), and the Owner thereupon shall process final payment. In the event that further work is required to complete this project, the Contractor shall be prepared to continue work, without additional compensation, until the system is accepted.

END OF SECTION 27 41 16

DIVISION 28
ELECTRONIC SAFETY AND SECURITY

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The following documents apply to all required work for the Project: (1) the Contract Drawings, (2) the Specifications, (3) the General Conditions

B. Division 08 Section “Door Hardware”

C. Division 26 Section “Grounding and Bonding for Electrical Systems”

D. Division 26 Section “Hangers and Supports for Electrical Systems”

E. Division 26 Section “Raceway and Boxes for Electrical Systems”

F. Division 27 Section “Communications Horizontal Cabling”

G. Division 27 Section “Communications Equipment Room Fittings”

H. Division 27 Section “Communications Connecting Cords, Devices and Adapters”

I. Division 28 Section “Access Control and Intrusion Detection”

J. Division 28 Section “Electronic Surveillance”

1.2 SUMMARY

A. Work Included:

1. Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

    a. Provide labor, materials and equipment necessary to complete the work of the Electronic Safety and Security (ESS) Systems, including but not limited to the following:
    b. Grounding and bonding for Electronic Safety and Security (ESS).
    c. Pathways for ESS.
    d. Lightning and Surge Protection for ESS.
    e. Vibration and Seismic Controls for ESS.
    f. Equipment Enclosures for ESS.
    g. Electronic Components for ESS.
    h. Exposed Components.
    i. Cables for ESS.
    j. Identification for ESS.
    k. Electronic Safety and Security (ESS) equipment coordination and installation.

2. The Electronic Safety and Security (ESS) Systems, include but are limited to:

    a. Access Control System (ACS)
    b. Video Surveillance System (VSS).
    c. Associated cabling, enclosures and uninterruptible power supplies.
    d. Coordination:

        1) Coordination with door hardware
        2) Coordination and interface with the fire alarm system to tie the electrified locks power supplies to the building fire alarm
        3) Coordination with other trades

1.3 ABREVIATIONS AND DEFINITIONS

A. Abbreviations

ACS	Access Control Alarm Monitoring System
ACP	Access Control Panel
AFF	Above Finished Floor
ANSI	American National Standards Institute
AWG	American Wire Gauge
CPU	Central Processing Unit
CR	Card Reader
CRT	Computer Terminal with Keyboard
EIA	Electronic Industries Alliance
ESS	Electronic Safety and Security
FCC	Federal Communications Commission
Fps	frames per second
GUI	Graphical User Interface
IP	Internet Protocol
LAN	Local Area Network
LPS	Lock Power Supply
Mbps	Megabits per second
MC	Magnetic Contact
MHz	Megahertz
NIC	Network Interface Card
NVR	Network Video Recorder
RMS	Rack Mount Space (1.75”)
RU	Rack Unit (1.75”)
RAID	Redundant Array of Independent Disks
RAID0	Block Level Striping without Parity or Mirroring
RAID5	Block Level Striping with Distributed Parity
SCP	Security Control Panel
SCS	Structured Cabling System
SDK	Software Development Kit
SSA	Software Support Agreement
SMS	Security Management System
TB	Terra Bytes
TCP/IP	Transmission Control Protocol / Internet Protocol
UL	Underwriters Laboratories
UPS	Uninterrupted Power Supply
UTP	Unshielded Twisted Pair
VSS	Video Surveillance System
WAN	Wide Area Network

B. Definitions

1. “Provide” shall mean furnish and install.

2. "Work" shall mean all labor, materials, equipment, apparatus, controls, accessories, and all other items required for a proper and complete installation.

3. "Concealed" shall mean hidden from sight in chases, furred spaces, shafts, embedded in construction or in crawl space.

4. "Exposed" shall mean not installed underground or concealed as defined above.

5. "Furnished by others" shall mean materials or equipment purchased and set in place under other sections of the general contract and connected to the systems covered by this section of the specifications by this trade contractor.

6. "Coordinate" shall mean all work provided under this section of the specification shall be in compliance with work of other trades.

7. "Demonstration" shall mean the verification by operation, movement or adjustment of an item or system and the comparison of the item or system performance against a qualitative standard or standards as set forth in the specific requirements of the cited paragraph.

8. "Test" implies the systematic exercising of an item or system under all specified conditions with quantitative measurement of specified parameters and comparison of performance against the quantitative standards set forth. The Security Contractor shall pre-test/pre-commission the installed system before the the Vassar college Representatives shall test the system. It is the Security Contractors responsibility to provide sign-off sheets to the Vassar college Representatives certifying that the system is ready for testing and commissioning.

9. Base Design/System: The intent of this phrase(s) is to describe the security systems specified herein,. The base design and base system present minimum acceptable performance levels and Vassar college desire to provide priority consideration to the most economic security system that meets these performance levels.

10. Security Contractor: This term designates the company which conducts the Work and is responsible to ensure that others provide specified Work as described in the Specifications for security systems. This term specifically refers to a company that is qualified to perform the Work specified herein related to the integration of all electronic security access control systems and components and the fabrication and installation of all security equipment.

11. Electrical Contractor: The Electrical Contractor shall furnish and install all security system interconnecting conduits, junction boxes, outlet boxes, electrical troughs, cable ladders, plywood backboard and other associates mounting hardware. Interconnecting security conduits shall be installed with a nylon pull string inside the conduits for installation of interconnecting conductors. In addition, the Electrical Contractor shall install the electrical power for the security system. The Electrical Contractor shall refer to the electrical drawings and electrical specifications for installation requirements.

12. Door Hardware Supplier: The Company engaged to provide materials and services for all door hardware, door frames, and mechanical locking hardware.

13. Door/Frame Security Hardware Package: This term signifies the security hardware package associated with a security access controlled and/or alarm monitored door. Security door hardware includes an electrified lock, electric strike, electrified panic hardware, electric power transfers or electrified hinges, magnetic door contacts, lock power supplies, termination cabinets, and final connection of wiring to door security devices and to the appropriate screw terminals on the screw-type termination strips located in the termination box.

1.4 STANDARDS AND CODES

A. Ensure that the design and fabrication of the equipment is in accordance with applicable Commissionering codes and standards. When specific requirements are stated in this Section that exceed and/or overlap those requirements of the codes and standards referenced here, this Section shall govern.

B. Ensure compliance with all applicable prevailing codes and laws within the jurisdiction of the site as applicable to the extent of this section.

C. Provide a complete fully operational turnkey security system as specified within these documents.

D. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The most current version of the following standards shall be referenced.

1. American National Standards Institute (ANSI) Publications:

   a. National Electrical Safety Code

2. American Society for Testing and Materials (ASTM) Publications:

   a. Standard Practice for Security Commissionering Symbols

3. National Fire Protection Association (NFPA) Publications:

   a. National Electrical Code

4. National Electrical Manufacturers Association (NEMA) Publications:

   a. Industrial Control Devices and Assemblies.
   b. Enclosures for Industrial Controls and Systems
   c. Enclosures for Industrial Controls and Systems
   d. Enclosures for Electrical Equipment

5. Underwriters Laboratories, Inc., Standard for Safety:

   a. UL 5 Surface Metal Raceways and Fittings
   b. UL 6 Rigid Metal Conduit
   c. UL 50 Cabinets and Boxes
   d. UL 65 Electric Wired Cabinets
   e. UL 83 Thermoplastic-Insulated Wires
   f. UL 96 Lightning Protection Components
   g. UL 193 Fuses
   h. UL 294 Access Control System Units
   i. UL 437 Key Locks
   j. UL 444 Communication Cables
   k. UL 486A/B Wire Connectors and Soldering Lugs
   l. UL 493 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
   m. UL 497B - Protectors for Data Communication and Fire Alarm Circuits
   n. UL 512 Fuse Holders
   o. UL 514B Boxes, Fittings for Conduit and Outlets
   p. UL 603 Power Supplies For Use With Burglar-Alarm Systems
   q. UL 609 Local Burglar Alarm Units and Systems
   r. UL 611 Central-Station Burglar-Alarm Systems
   s. UL 632 Electrically Actuated Transmitters
   t. UL 634 Connectors and Switches For Use With Burglar Alarms Systems
   u. UL 639 Intrusion Detection Units
   v. UL 651 Conduit, Schedule 40' and 80' Rigid PVC
   w. UL 796 Electrical Printed Wiring Boards
   x. UL 797 Electrical Metallic Tubing
   y. UL 827 Central Stations For Watchman, Fire-Alarm, and Supervisory Services
   z. UL 1037 Anti-theft Alarms and Devices
   aa. UL 1076 Proprietary Burglar Alarm Units and Systems
   bb. UL 1773 Boxes, Termination

6. Applicable Federal, state and local laws, regulations, ordinances and codes.

7. Nothing in this Section, including revocation of certain specific codes, standards or specifications, shall relieve the Security Contractor of the responsibility for compliance with the codes, standards or specifications which are generally recognized to be applicable to the Work specified herein.

1.5 SUBMITTALS

A. General Procedures

1. All submittals shall comply with the requirements of Division 01.
2. Do not commence work that requires review of any submittals until receipt of returned submittals with appropriate final action.
3. Submittals that deviate from the procedures outlined herein will be rejected. No allowance or extension of project time will be considered due to lost time associated with procedural deviation.
4. Do not submit substitute items that have not been approved.
5. Preparation and Transmittal of Submittals:
6. Transmit each submittal with a transmittal form. Submittals received without a transmittal form may be returned without action. The transmittal form shall include: project name and address, number and date of submittal, name and address of the issuing entity.
    a. Sign or initial each copy of each submittal to certify compliance with requirements of the Contract Documents.
    b. Submittals shall include a Table of Contents listing all items included and relevant references to contract documents. For product data sheets the table of contents shall include: product name and manufacturer, page number of the corresponding specification section.
    c. Product data sheets shall be grouped according to the specifications sections. Submittals shall include relevant information only. Product being submitted shall be clearly identified.
7. Timing of Submittals
    a. Prepare and transmit each submittal requiring approval sufficiently in advance of scheduled performance of the related work to allow for adequate review and processing time, including time for re-submittal if necessary.
    b. If processing time for a particular submittal will be critical to progress of the work, advise and notify the Vassar College or its representatives accordingly.

B. List of Submittals:

1. Pre-Construction Submittals:
    a. Quality Assurance (QA) Plan
    b. Qualifications and Certificates
    c. Materials and Equipment List
    d. Product Data for every product installed
    e. Manufacturer Quality Assurance Tests and Source Quality Control Reports
    f. Shop drawings
    g. Samples
2. During Construction:
    a. Coordination Drawings
    b. System Labeling
3. Post Construction:
    a. Test Plan and Procedures
    b. Field Quality Control Reports/Test Results
    c. Record (as-built) Drawings
    d. Spare Parts List
    e. Manuals
    f. Maintenance Support
    g. Warranties

C. Quality Assurance Plan: submit a QA plan and reporting program containing a project schedule with anticipated milestone dates for all project related tasks (i.e. shop drawing submittal, various construction milestones, testing, acceptance, etc.).

D. Qualifications and Certificates

1. Installer Qualifications:

   a. Qualification Data: The work specified herein shall be performed by a qualified installer, as defined and described herein.
   b. Installer shall be certified installer for the specific manufacturers and systems provided.

2. Seismic Qualification Certificates: For equipment frames from manufacturer.

   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Materials and Equipment List:

1. Complete list of all materials, equipment and accessories proposed for his Work. This list shall include manufacturers, complete catalog identification numbers and model or system designator, quantities, options, product data as described below, basic system Commission block diagrams, and CPU software operating features.
2. The submittal shall be in sufficient detail so that the equipment and materials proposed can be readily identified.
3. Submittal of partial lists is not acceptable.

F. Product Data:

1. For each type of product indicated.

2. Shall be ordered by specifications section. Each product data shall reference the appropriate section and subsection.

3. Collect Product Data into a single submittal for each element of construction or system.

4. Include construction details, material descriptions, dimensions of individual components and profiles, and standard colors and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Is shall also include roughing-in diagrams and templates, standard wiring diagrams, controls and performance curves. Where Product Data must be specially prepared or modified because standard printed data is not suitable for use, submit as “Shop Drawings”.

5. Clearly mark each copy to identify pertinent products, models, and accessories. Show performance characteristics and capacities. Show dimensions and clearances required. Include the following information:

   a. Reference to appropriate specification section and subsection.
   b. Compliance with recognized trade association standards.
   c. Compliance with recognized testing agency standards.
   d. Application of testing agency labels and seals.
   e. Notation of dimensions verified by field measurement.
   f. Notation of coordination requirements.
   g. Manufacturer's printed recommendations.

G. Samples: Along with project data and shop drawings, submit one (1) sample for each exposed security devices and security devices with color and finish options, for review by the Commissioner. The Vassar College Representatives/Commissioner shall retain these devices as record of the approved equipment for the length of the project.

H. Shop Drawings:

1. The shop drawing submittals shall include highly detailed, to-scale, drawings describing the products (systems, equipment, devices and materials) and services as to precise locations, mounting and installation methods, details and dimensions, schedules, conduit sizing, conduit routing, riser diagrams, point-to-point interconnect diagrams, equipment schedules, zoning schedule, door schedules, VSS camera schedules, system interface schedules or diagrams, power requirement schedules, stand-by/emergency power schedule, cost reports, and such other diagrammatic or written descriptions which shall allow a thorough and accurate understanding of the security systems and equipment that are being furnished, how they are intended to function, how they will be installed, and all other necessary information of similar intent.
2. No work shall not commence nor shall any equipment be ordered until the submittals have been approved in writing. All work shall be in accordance with approved submittals. A detailed completion schedule shall be submitted with all submittals.
3. Indicate, among other requirements noted herein, the accurate locations of all conduit, raceway, junction and utility boxes, termination panels, transformers (if any), power supplies, panels, and all other equipment noted.
4. Clearly illustrate all mounting locations and methods, with particular detail for the installation of intrusion sensors, locking hardware, and request-to-exit devices at doors, sensors located at windows and the mounting of interior and exterior VSS cameras. While some drawing details may be “typical,” the shop drawings shall illustrate the installation detail of each unique application.
5. Include plans, elevations, sections, details, and attachments to other work.
6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
7. Equipment schedules and details shall provide the following information, as appropriate in each case: door number; door type; door position switch; request-to-exit type; request-to-exit location; auxiliary request-to-exit device, if any; lock type; power requirements; emergency power; access control type; special installation requirements; timed-shunt times; shunt type; precise, to-scale mounting location; zone or point designation; remote control of lock by specific and designated control console; VSS camera number activated by sensor or switch closure; input/output programming schedules; CPU output reports structure.
8. Camera schedules and details shall provide the following information: camera number; camera type; monitor number for each camera (if any); sequencing [if any]; camera model number; camera features, such as auto-iris; lens specification; power requirements; type of power input; cable type; length of cable run; camera mounts; camera housing; camera housing features, such as heater, etc.; camera drives; switcher position; switcher type; monitor type; cameras displayed on each monitor, especially linked displays; DVR positions; alarm queuing; special installation or carpentry requirements; camera and/or lens controls; alarm homing; termination method; lightning, ground loop, etc. protection.
9. Clearly illustrate the fields of view of each camera, as well as “park” positions for panning and zooming cameras (if any). If the camera is capable of wide-angle and telephoto viewing, both fields of view shall be indicated. The installer's “aiming point” shall be indicated. The submittal shall clearly identify outdoor cameras mounting details and maintenance access concepts and design.
10. System interface schedules or diagrams shall clearly identify: sensors and switches which queue cameras, as well as the number of camera activated; DVR activation logic; VSS monitor switching logic; interfaces, if any, between the access control system; distributed processing capabilities and functions; sensors and switches exclusively used as request-to-exit devices.
11. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
12. Exposed equipment: Submit one (1) sample for each exposed security devices and security devices with color and finish options, for review by the Commissioner and Commissioner. The Commissioner/Commissioner shall retain these devices as record of the approved equipment for the length of the project.
13. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

I. System labeling: submit labeling scheme and samples.

J. All post construction submittals must be presented and approved prior to final acceptance.

K. Formal Test Plan and Procedures: 30 days prior to acceptance testing and final inspection, submit a formal test plan and test procedures.

L. Spare Parts and Components List: At the conclusion of the work, submit a complete list of manufacturers' recommended spare parts and components required in order to satisfactorily maintain and service the systems for a minimum of two years.

M. Manuals:

1. Prior to final acceptance, complete sets of Operation, Maintenance and Service Manuals shall be submitted for systems and equipment provided under this contract.

2. The manuals shall be compiled, assembled and indexed, in an easily identifiable hard cover form. Three (3) sets of the manuals shall be submitted prior to final acceptance testing.

3. The manuals shall include the following:

   a. Complete operating instructions.
   b. Complete maintenance instructions, wiring diagrams, troubleshooting instructions.
   c. System service instructions for work which manufacturers recommend user service.
   d. Complete parts lists for each major item of equipment and/or for each system.
   e. Complete collection of manufacturers' product and catalog literature for equipment and systems installed under this contract.
   f. Manufacturers' warranties.
   g. Operating characteristics, performance data, ratings, and manufacturers' specifications for each item of equipment or system.
   h. Where practical, internal wiring diagrams and schematics.
   i. Name, address, and telephone number for service for each item of equipment or system.
   j. Software User Documentation: Manual shall include operating instructions, programming instructions, technical documentation and maintenance procedures to permit making changes to system configuration.

N. Record Drawings

1. Produce, and keep up-to-date, a complete record as-built set of prints (black-line bonds) which shall be corrected, and marked-up to show every change from the original Specifications and Contract Drawings through final acceptance. This set of drawings shall be protected against soiling, tears, and similar damage and defacement. This set shall be kept on the job site and shall be used only as a record set. (This shall not be construed as authorization to make changes in the Work without proper approvals.)

2. The as-built drawings will be kept up-to-date and will be checked monthly as a requirement for approval of monthly progress payments.

3. Upon completion of the work and before final payment, produce and submit a final set of record drawings by updating the AutoCAD files of the construction set of drawings with the information from the as-built set. The submittal shall include the original record set of black-bonds and the electronic files of the as-built drawings in both AutoCAD format and PDF format.

4. At the conclusion of this project, two sets of black-line bond and two copies of the drawing files on Windows based media, formatted for use by AutoCad 2009 (or later version), of all the security drawings specifically prepared for this Contract, shall be provided. The drawings shall be instrument drawn and shall contain all changes shown in the record set. Sepia line drawings on paper are not acceptable.

O. Service/Maintenance Support

1. Maintenance and repair of the system (parts and labor) shall be provided free of charge during the warranty period, including repair of workmanship defects. Free software upgrades during the warranty period.

P. Warranties

1. All components, parts and assemblies supplied as part of this scope of work shall be warranted against defects in material and workmanship for a period of at least twelve (12) months (parts and labor), commencing upon the date of acceptance by the Vassar College. A qualified factory-trained service representative shall provide warranty service.

2. As a condition precedent to the final payment, execute a written guarantee (warranty) to the Vassar College certifying that all the contract requirements have been completed in accordance to the final Specifications and Contract Drawings and warranting all materials and equipment furnished by him under this contract to remain in satisfactory operating condition (ordinary wear and tear, abuse and causes beyond his control for this Work excepted) for a period of one (1) year from the date of final acceptance or beneficial use, whichever is later.

3. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay to Vassar college satisfaction at no cost to the Vassar College.

4. Provide four (4) periodic inspections at no cost to Vassar College during the warranty period.

5. When equipment and labor covered by the installer's warranty or by a manufacturer's warranty have been replaced or restored because of his failure during the period of that warranty, the warranty period for the replaced or repaired equipment or restored work shall be reinstated for a period of time equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event that any manufacturer customarily provides a warranty period greater than one (1) year, the Security Contractor's warranty shall be for the greater period of time.

6. In no case shall the integrated system/security equipment warranties be voided where user-programmable programming changes are performed by the trained Vassar College appointed system programming representative, to include redefining system input/output points, operation characteristics, time delays, and report formats to Vassar College site-particular requirements.

7. Free software upgrades during the warranty period.

Q. Definition of Acceptance

1. Vassar College acceptance of the installation will be based upon satisfactory performance during a thirty (30) day period of beneficial use beginning after all of the other acceptance requirements listed below have been satisfied in full by Vassar College.

2. Acceptance of the installation will be reasonably and good faith determined by Vassar College or its agents. Partial use of the installation prior to completion will not be considered as contributing in part or in whole to the thirty-day period. Problems discovered during the thirty (30) day period covered under the responsibilities of the Vendor must be fixed at no cost to Vassar College.

3. Acceptance will not be given, and no final payments will be made, until all problems have been fixed to Vassar College full satisfaction. Acceptance does not absolve the installer from any of its obligations under warranties and guarantees. The other acceptance criteria are the following:

4. All tests have been passed and all required test results have been submitted in appropriate format and have been accepted without dispute by Vassar College.

5. All required documentation has been submitted.

6. All required labeling has been completed.

7. All work has been completed as required by the specifications, including all cable runs and pathways in their permanent places, and all cabinets, racks and cable pathways (i.e. ladder, tray, etc.) secured.

8. All Punch List items have been completed.

9. All warranties for the installation have been obtained by installer.

10. The Security Contractor has submitted written notification that the installation is completed and that all specification requirements have been met.

11. Upon satisfactory completion of acceptance requirements by the Security Contractor, and after satisfactory performance during the thirty (30) day period, and correction of any defects found, Vassar College will notify the Security Contractor in writing of its acceptance of the installation.

1.6 SUBSTITUTIONS, DEVIATIONS AND CHANGES

A. Substitutions

1. Requests for substitution are permitted for materials specified with an "or approved equivalent" clause or other language of same effect in the Contract Documents. No request for substitution will be entertained if this clause has not been specified.

2. Request for substitution shall be submitted before, or with the bid response.

3. All requests for substitution shall be accompanied by a product data sheet submittal as outlined in paragraph 1.5 above.

4. Vassar College or duly authorized representative has no obligation to consider or approve requests for substitution after award of contract.

5. Substitutions may be permitted if the requirements of the proposed substitution comply with the general requirements and product specifications of the Contract Documents.

B. Deviations

1. Any deviations or changes involving extra work are not permissible without prior review and written approval by Vassar College or its duly authorized representative.

C. Changes

1. All work described in Contract Riders shall follow the methods, requirements and general arrangement of this Specification unless otherwise noted.

2. All pricing and proposals for changes shall be submitted detailing all items and related costs in accordance with the provisions of the Contract for changed work.

3. The Security Contractor may be required to provide sufficient manpower to install systems and cabling not specified herein. The Security Contractor, if required, shall provide this work at the labor rates specified, without negative impact on the project schedule.

1.7 TRAINING

A. Engage factory-authorized service representatives to train Vassar College maintenance personnel to adjust, operate, and maintain security access systems.

B. Refer to Division 01 Section "Demonstration and Training"

C. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel.

D. The following establishes basic and minimum training requirements. The Security Contractor shall provide technical services and materials to instruct operators, maintenance persons, and programmers/database set-up personnel to operate, maintain and program the system. The Security Contractor shall provide training for no less than 5 personnel selected by Vassar College.

E. Training of console operators & maintenance personnel:

1. The instruction shall be provided by a competent factory trained Commissioner or professional instructor (that has completed manufacturer's training) representing the Security Contractor.

2. Provide each operator with complete, printed operating instructions and a brief sub system description in manual or handbook form. Training manuals shall be delivered for each trainee with two additional copies delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson.

3. The operators shall be trained in preventative maintenance of equipment.

4. Certification of successful operators shall be provided upon the completion of training. Certification shall consist of correspondence drafted on the Security Contractor's Company Letterhead stating that Vassar College staff has been trained in accordance with the contract documents and manufacturers standards and are fully proficient in the operation of the newly installed Security System.

F. Where the Security Contractor presents portions of the course by audio-visual material, copies of the audio-visual material shall be delivered to the either as a part of the printed training manuals or on the same media as that used during the training sessions.

G. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Security Contractor should assume that attendees will have a high school education or equivalent and are familiar with the facility. Approval of the planned training schedule shall be obtained from Vassar College at least 10 days prior to the training.

1.8 QUALITY ASSURANCE

A. Unless otherwise specifically noted, all equipment, material and articles to be installed shall be new, best of their respective kinds, free from defects, listed by Underwriter's Laboratories for the intended use, bearing their label and of the most suitable grade for the purpose intended.

B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Security Contractor.

C. Unless otherwise specifically noted, reference to any equipment, material, article or patented process, by trade name, make or catalog number shall be regarded as establishing a standard of performance and quality. Provide the name of the manufacturer, the model number and other identifying data and information respecting the performance, capacity, nature and rating of the electrical, mechanical and other equipment that the Security Contractor contemplates incorporating in the work.

D. When so directed, samples shall be submitted for approval at no cost to the Vassar College. Equipment, material and articles procured, installed, or used without required approval shall be at the risk of subsequent rejection. Warranties for all installed products shall be in accordance with the Contract General Provisions and as cited herein.

E. The services of a qualified manufacturer's technical representative, thoroughly experienced in the installation and operation of the type of system being provided shall be obtained by the Security Contractor, at no cost to Vassar College, to consult on equipment selection, installation, and testing of the specified systems if and as requested by the Vassar College or its authorized representatives.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Grounding: Comply with ANSI-J-STD-607-A.

H. Modularity: Provide components designed for modular increase or decrease of system capability by installation or removal of plug-in modules. System components shall be designed to facilitate modular subassembly and part replacement.

I. Reliability: Provide only new, unused components free from flaws or imperfections, which are in current manufacturing production. Components shall be manufactured to meet all the requirements specified herein and shall be free from characteristics or defects which affect the appearance or which might affect the serviceability or render the equipment unsuitable for the intended purpose. The workmanship shall be of superior quality. The MTBF for any sensor component shall not be less than five-thousand (5000) hours. Provide components designed

for continuous operation. Electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL seven-hundred-ninety-six (UL-796). Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. Power-dissipating components shall incorporate safety margins of not less than twenty-five (25) percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity. Light duty relays and similar switching devices shall be solid-state type or hermetically sealed electro-mechanical type.

J. Maintainability: The components shall be capable of being maintained using commercially available standard tools and equipment. Components shall be so arranged and assembled that they are readily accessible to maintenance personnel without compromising the defeat resistance of the various ESS subsystems.

K. Availability: Provide products and services available within the project schedule established for this scope of work.

1.9 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of the Construction Indoor Air Quality Management Plan and the Construction Waste Management Plan.

B. Deliver materials in original packaging, bearing brand name and identification of manufacturer or supplier.

C. Store materials to keep them dry and protected from soiling, dirt or damage. Neatly stack gypsum boards flat to prevent sagging.

D. Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect trim accessories from being bent or damaged.

1.10 PROJECT CONDITIONS

A. Waste Management: Comply with the requirements of the Construction Waste Management Plan.

B. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

C. Where required by local code, trade harmony shall be observed by using only approved union (IBEW or CWA) based installation workforce. Coordinate with Vassar College or its authorized representatives.

1.11 COORDINATION

A. Coordinate layout and installation of security equipment in the telecommunications rooms, copper and/or fiber backbone and LAN requirements with Vassar College and the Structured Cabling System (SCS) installer.

B. Meet jointly with Vassar College to exchange information and agree on details of equipment arrangements and installation interfaces.

C. Record agreements reached in meetings and distribute them to other participants.

D. Coordinate location of power raceways and receptacles with locations of security equipment requiring electrical power to operate.

E. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. Connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

G. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

H. Coordinate sleeve selection and application with selection and application of firestopping specified in the Electrical Section.

I. Coordinate routing of the security cables.

J. Coordinate the installation of the door/frame security package with the door hardware supplier. Security door hardware includes an electrified lock, electric strike, electrified panic hardware, electric power transfers or electrified hinges, magnetic door contacts, lock power supplies, termination cabinets, and final connection of wiring to door security devices and to the appropriate screw terminals on the screw-type termination strips located in the termination box. Responsibility for furnishing and installing a typical Door/Frame Security Package is divided as follows:

1. Door Hardware Supplier responsibilities:

    a. Shall furnish and install factory-prepared door frame fitted with factory prepared cut-outs and appropriate pre-welded outlet boxes to accept the door security devices.
    b. Shall furnish and install all non-security mechanical hardware. This shall include but not limited to mechanical hardware, hinges, door closers, door stops, etc.
    c. Shall furnish all electronic locksets, power transfer hinges, door monitoring contacts, request-to-exit devices for the new doors.

2. Security Contractor responsibilities:

    a. Shall install all door monitoring contacts, electromagnetic locks, shear locks, and request to exit devices for the existing doors. Devices shall be retrofitted to the exiting doors, as specified on the drawings.
    b. Shall install all magnetic contacts and electronic locksets and power transfer hinges, provided by the door hardware supplier, as specified on the drawings.
    c. Shall furnish and install termination cabinet furnished with screw-type termination block(s). The termination block(s) shall include additional screw terminals to accept the wiring interconnect inputs from the card reader(s), request-to-exit passive infrared detectors and/or the request-to-exit push button switch, and shunt switch, as required, which are not part of the door/frame security hardware package.
    d. Shall coordinate with the Electrical Contractor who will be providing all hi-voltage power to security equipment ad required, including but not limited to, the types and sizes of interconnecting wiring, outlet box sizes, electrical contacts needed and screw terminal sizes.
    e. Shall coordinate with the electrical contractor who will be providing Fire Alarm relays for interfacing with the electrified locking devices power supplies.
    f. Shall coordinate with the elevator vendor who will be providing elevator cars, controllers and traveling cables.
    g. Shall coordinate with Telecommunications Contractor who will be providing data connections for the cameras, control panels, servers, workstations and any other security equipment that requires data or telephone connectivity.
    h. Shall coordinate with the VASSAR who will be providing the Local Area Network (LAN) switches).
    i. Shall coordinate with the building security for access control cards, elevator interface and visitor management system.

3. Electrical Contractor responsibilities:

    a. Shall furnish, install and final connect all security door conduits and interconnect wires from door power supply and termination cabinet and/or junction box to all security devices associated with a door/frame security door location.
    b. Shall furnish and install all other security system interconnecting conduits, junction boxes, outlet boxes, electrical troughs, and other associated mounting hardware. Interconnecting security conduits shall be installed with a nylon pull string inside the conduits for installation of interconnecting conductors.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING FOR SECURITY SYSTEMS

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.2 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

A. Hangers and Supports

1. Cable Support: NRTL labeled.
2. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
3. Cable hangers and non-continuous supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
4. Shall have various attachment options for: wall, ceiling, joist, beam, flange, raised floor pedestal and others type of mounting.
5. Support brackets with cable tie slots for fastening cable ties to brackets.
6. Lacing bars, spools, J-hooks, and D-rings, straps and other devices.
7. Cable straps (ties) shall be reusable Velcro-style with hook and loop or d-ring, available in various colors and sizes. Plenum rated straps shall be used in plenum spaces.

B. Conduits and Back Boxes:

1. Provide where indicated on drawings or as required.
2. Conduit and boxes sizes as shown on the communications drawings.
3. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
4. Flexible metal conduit shall not be used unless specifically noted.

C. Sleeves

1. Refer to Division 26 “Electrical”.

D. Sleeve Seals and Firestopping

1. Install to seal exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal
3. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

E. Grout

1. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3 LIGHTING AND SURGE PROTECTION

A. Intrusion detection, access monitoring and control, video circuitry, and communication circuits that connect to outdoor mounted equipment shall be protected at both ends against excessive voltages.

B. This requirement shall apply for circuits that are routed both in underground conduits and overhead runs. As a minimum, both primary detection devices, such as three (3) electrode gas-type surge arrestor, and secondary protectors shall be installed to reduce dangerous voltages to levels that will cause no damage. Fuses shall not be permitted as lightning and power surge protection devices.

C. Provide fail-safe gas tube type surge arrestors on all exposed security data circuits. Breakdown voltage for the unit shall be three-hundred to five-hundred (300-500) VDC. The unit shall have equal performance for bi-polar operation with an automatic reset feature, and a minimum life of one thousand (1000) surges with ten (10) times one-thousand (1000) microsecond wave-form at one-thousand (1000) amperes.

2.4 VIBRATION AND SEISMIC CONTROLS FOR ESS

A. Security systems components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. The term “withstand” means “the unit will remain in place without separation from any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event”.

C. Equipment shall be seismically rated and braced according to IBC 1621.

2.5 IDENTIFICATION FOR SECURITY ESS

A. Comply with requirements of Division 26 Section "Identification for Electrical Systems".

B. The identification for the communications systems shall meet all the requirements of a Class 3 facility as defined by ANSI/TIA/EIA 606-A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

C. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. Identify all the components of the security systems.

E. For fire-resistant plywood, do not paint over manufacturer's label.

F. All labels shall be preprinted or computer-printed type.

G. Type, format, wording, printing, and placement of labels shall be coordinated with VASSAR’s existing administration plan

H. Labeling System

1. PC-based software, WINDOWS compatible, capable of supporting alpha numeric characters and Windows True Type Fonts.
2. Compatible with laser printers.
3. Label sizes supported:
4. Minimum: 0.8" W x 0.2" H.
5. Maximum: 3.0" W x 12.0" H.

2.6 EXPOSED COMPONENTS

A. Components exposed and accessible to the public shall be of a design and construction typical and suitable for such use. All device fasteners shall be an approved security type. All components and materials shall be resistant to vandalism and waterproof.

2.7 ELECTRONIC COMPONENTS FOR ESS

A. All electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL seven-hundred-ninety-six (UL 796). Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. All power dissipating components shall incorporate safety margins of not less than twenty-five (25) percent with respect to dissipation ratings, maximum voltages, and current-

carrying capacity. All electronic printed circuit boards furnished and installed shall be provided with a mildew/fungus-resistant and moisture inhibiting coating.

2.8 CABLES FOR ESS

A. All cables installed in plenum spaces shall be plenum rated.

B. Jacket color shall be yellow for all security cables.

C. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1. NFPA 70, Type CM.

2. Flame Resistance: UL 1581 Vertical Tray.

3. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

4. NFPA 70, Type CMP.

5. Flame Resistance: NFPA 262 Flame Test.

D. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet.

1. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.

2. NFPA 70, Type CMP.

3. Flame Resistance: NFPA 262 Flame Test.

E. Multiconductor, PVC Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CMG.

2. Flame Resistance: UL 1581 Vertical Tray.

3. For TIA/EIA-RS-232 applications.

F. Paired PVC Readers and Wiegand Keypads Cables: Paired, 3 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CM.

2. Flame Resistance: UL 1581 Vertical Tray.

G. Paired PVC Readers and Wiegand Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CM.

2. Flame Resistance: UL 1581 Vertical Tray.

H. Plenum-Type, Paired, Readers and Wiegand Keypads Cable: Paired, 3 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum foil-polypropylene tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

I. Plenum-Type, Multiconductor, Readers and Wiegand Keypads Cable: 6 conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

J. Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.

1. NFPA 70, Type CMG.
2. Flame Resistance: UL 1581 Vertical Tray.

K. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

L. Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.

1. NFPA 70, Type CMG.
2. Flame Resistance: UL 1581 Vertical Tray.

M. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

N. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CMR.
2. Flame Resistance: UL 1666 Riser Flame Test.

O. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

P. Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.

1. NFPA 70, Type CMG.

Q. Plenum-Type, Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

R. LAN Cabling: Comply with Division 28 Section "Conductors and Cables for Electronic Safety and Security."

1. NFPA 262.

S. Composite Cable:

1. Element 1 (Lock Power): 18 AWG, 4 Conductor Non-Shielded Plenum
2. Element 2 (Card Reader): 22 AWG, 3 Pair Overall Shielded Plenum
3. Element 3 (Door Position Switch): 22 AWG, 2 Conductor Non-Shielded Plenum
4. Element 4 (Request to Exit Device): 22 AWG, 4 Conductor Non-Shielded Plenum

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR SECURITY SYSTEMS INSTALLATION

A. All materials shall be installed as per the manufacturers' instructions, unless noted otherwise.

B. Comply with NECA 1.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Right of Way: Give to piping systems installed at a required slope.

G. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

H. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

I. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

J. Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely, paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore all surfaces to their original condition.

K. All wall-mounted equipment shall be mounted square and plumb.

L. Complete work according to the agreed upon schedule. Cooperate in coordinating your activities with other planned and ongoing work at the site in a manner that facilitates meeting the schedule. This includes coordination with the various trades in determining work schedules and in resolving physical installation issues.

M. All materials, cables, components, and all aspects of the installation must meet all local, state, and federal laws, as well as applicable code and regulatory requirements. They must also meet the requirements of any other entity legally empowered to set standards or codes governing composition and use in this installation, as well as any rules specific to the site. Code and regulatory requirements must prevail if there are any conflicts with requirements stated or implied in this specification and its companion documents. Where there is uncertainty in determining precedence, or what specific code or regulatory requirements apply, an Authority Having Jurisdiction (AHJ) over the issue in question will decide.

N. Vassar College reserves the right to require the Security Contractor to remove from the project any employee that it deems careless, problematic, or is identified by competent authority as not conforming to required safety codes,

regulations, or standards, or is cited for performing or acting in an objectionable manner, thus affecting the safety or productivity of others.

O. Take all necessary safety and health precautions and warnings required by codes and regulations to protect the project, its workers, the public, and the property of others. Applicable OSHA regulations or AHJ directives must be followed.

P. Accept responsibility for all damages to persons or property that occurs as a result of its fault or negligence.

Q. Designate a Project Manager to act as the technical and managerial interface with the Client and or its representatives.

R. Participate in meetings covering technical, installation, and coordination and management issues.

S. Perform all work required under this specification in a skillful and professional manner in accordance with standards and practices documented and/or accepted by industry, such as the ANSI/TIA/EIA, NECA standards and codes. The Security Contractor's technicians must be familiar with the proper assembly and installation of all components they are working with and must follow manufacturer's specific installation requirements.

T. Maintain its installation and storage areas free from an accumulation of waste material and rubbish and dispose of them in a manner acceptable to the Client, building management and the General Contractor/Construction Manager.

U. Provide all tools needed to perform its required work. Upon completion of the project, all tools, equipment, and materials not designated as belonging to the Client must be removed. After completion, the work areas must be left in a clean and unobstructed condition.

V. Security Contractor must be responsible for the security of all its installation materials, whether purchased by, or supplied to the Security Contractor, as well as tools and ancillary components and documents.

W. Order all components in a timely manner so that installation dates are not compromised. Materials must either be on hand, or available on short notice, so that the installation may be expedited if required, or if the opportunity to do so presents itself.

X. Obtain all necessary permits.

Y. Ensure that any excess materials are ordered for the project they are kept in their original condition and packaging for restocking.

Z. Where required by local code, trade harmony shall be observed by using only approved union-based installation workforce.

3.2 GROUNDING AND BONDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

C. All cabling used to bond grounds are to be tagged with labels with the point of origin i.e. going to/coming from, with printed labels.

3.3 PATHWAYS INSTALLATION FOR SECURITY SYSTEMS

A. Comply with NECA 1.

B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

C. All conduits shall be electrical metallic tubing (EMT), except where otherwise noted. Exceptions shall be requested in writing as appropriate, such as for different conduit types for various classes of construction, such as for cast-in-place concrete, and placement in cable ducts. Minimum size of conduit shall be three quarter (3/4) inch. Connections shall be threadless type fittings or couplings. Fastenings and supports for conduit shall be in accordance with the national and local codes.

D. Security Contractor shall submit conduit and wire layout drawings showing circuit numbers, wiring and conduit routings for approval by the Commissioner prior to the initiation of Work. Shop drawings of the security systems conduit routing shall be coordinated by Security Contractor with fire wall construction, mechanical duct work, structural components, fire protection, and plumbing.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Care shall be taken to ensure that access to other building components (e.g., air conditioning ducts) is not restricted by cable pathways.

G. Cable management and support hardware must be UL listed for use in the environments in which they will be employed.

H. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

I. Secure conduits to backboard when entering room from overhead.

J. Extend conduits 3 inches above finished floor.

K. Provide metal conduits with grounding bushings and connect with grounding conductor to grounding system.

L. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

M. Pathways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Changes in direction of runs shall be made with symmetrical bends or cast metal fittings.

N. All conduits shall be affixed or supported at intervals and using prescribed methods and devices in accordance with governing codes. No run of conduit between outlets or fittings shall contain more than four quarter bends (360 degrees). Bends shall be made such that the conduit will not be injured and that the interval diameter will be effectively reduced.

O. All conduit connections shall be tight so as not to create intermittent loss of ground protection. All cut ends entering into fittings shall be reamed smooth or have a bushing inserted to prevent damage to wire insulation.

P. Conduit, raceways and other pathways shall be kept at least six inches from uninsulated flues, steam pipes or any pipe containing a hot gas or liquid. So far as practical, avoid traps and dips in conduit runs, which might collect moisture.

Q. Strict attention shall be given to all conduits containing fiber optic cabling to ensure that manufacturer's recommended conduit bend radii limitations/restrictions are followed.

R. Where conduits connect to sheet steel enclosures, they shall be fastened with two (2) locknuts where insulating bushings are used. Bushings shall be installed on ends of all conduits where they terminate in pull boxes, outlet boxes, cabinets, etc. and shall be of the insulating type and shall be securely fastened with locknuts on each side. Crushed or deformed conduits shall not be installed. Bushings shall not be used as locknuts. Open ends shall be sealed around security conductors to be liquid tight using an approved air-drying sealer after capping ends with insulated bushings.

S. Conduits crossing expansion joints in concrete slabs shall be provided with suitable expansion fittings, or other suitable means, to compensate for building expansion and contraction. Conduits traversing hazardous areas shall use the penetrations and fittings shown on the drawings and provided under other sections of the contract. Seal the fittings subsequent to verifying the integrity of the contained conductors.

T. Pathways shall not block ceiling or equipment access doors. Where conduit or raceway is passed through walls, floors, ceilings or roofs, annular space shall be sealed or patched. Openings in firewalls and all corridor walls shall be sealed with mineral wool or an approved silicone sealant.

U. No pathways shall be fastened to other pipe or conduit or installed so as to prevent the ready removal of other pipe or conduit for repairs.

V. Conduit, panels, devices and boxes shall be secured by means of shields in concrete, machine screws on metal surfaces and wood screws on wood construction material. Threaded studs driven in my power charge and provided with either lock-washers and nuts or nail type nylon anchors are not acceptable in lieu of machine screws. Wood

plugs shall not be used as expansion shields. Unless conditions or Drawings dictate otherwise, panels shall be located between 3'-6" and 6'-0" above floor level.

3.4 SLEEVES INSTALLATION FOR SECURITY SYSTEMS

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 50 mm above finished floor level.

F. Size pipe sleeves to provide 6.4-mm annular clear space between sleeve and pathway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

J. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 25-mm annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 25-mm annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Specification Section “Penetration Firestopping”.

B. Cable/wire runs and conduit shall be installed in accordance with applicable electrical Work standards, national and local codes as well as manufacturers' specifications of installed equipment.

C. Where required by local code, trade harmony shall be observed by using only approved union based installation workforce.

3.6 CABLE/WIRES INSTALLATION

A. Cable/wire runs and conduit shall be installed in accordance with applicable electrical Work standards, national and local codes as well as manufacturers' specifications of installed equipment.

B. All ESS conductors shall be separated from 240V primary power lines. ESS conductors shall not share any conduit in which primary power conductors are run. Junction and receptacle boxes carrying 240V, or higher voltage, shall not in any way be attached to or carry security systems conductors.

C. Conductors shall be copper, and shall not have a diameter less than eighteen (18) AWG unless otherwise indicated. Exceptions will be made for vendor-provided leads and internal equipment wiring. If required, modify equipment wiring fittings which will not accept eighteen (18) AWG minimum conductors. Conductors for intercom systems and for multiplexer data communications shall be a minimum of twenty-two (22) AWG. Other exceptions may be granted for use of smaller gauge conductors upon approval by the VASSAR's representatives.

D. Conductors interconnected to equipment subject to movement shall be stranded or shall be of a type manufactured specifically for such interconnections.

E. Wire fill, conductors, and conduit shall be sized in compliance with the National Electrical Code. The number of conductors required may vary on the basis of the manufacturers of the selected equipment. In no event, shall conduit fill exceed 40%.

F. In the event that ESS conductors must share conduit with other low voltage conductors, prior approval is required. All system conductors shall be run concealed wherever practical, and shall be placed in conduit.

G. All conductors shall be run continuously between sensors, processors, junction boxes, terminal strips or panels, and other approved devices. Splices between such locations are not to be permitted. Necessary junctions shall be made using screw-type terminal blocks, or in accordance with manufacturer's requirements for equipment connections.

H. Line supervision requirements shall be observed

I. All conductors shall be color coded and tagged consistently. Coordination with the VASSAR's representatives regarding the exact wire coding and tagging is mandatory. Transposing or changing color coding of conductors shall not be permitted. Conductor identification shall be provided within each enclosure where a tap, splice or termination is made, and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking will not be accepted. Marking shall be an approved permanent type utilizing an approved method. Tagging devices shall be approved and shall be permanent, not subject to inadvertent separation. All conductors at control consoles shall be bundled, neatly fanned out, and tagged. Cables and wires shall be tagged to clearly indicate their electrical characteristics, circuit number and panel designation. Tagging shall be such that several conductors may be disconnected and reconnected without the use of drawings.

J. If required by manufacturers' specifications, shielding requirements shall be observed.

K. Only approved pulling compounds shall be used. Pull strengths shall not exceed standards established by the National Electrical Code.

L. Submit conduit and wire layout drawings showing circuit numbers, wiring and conduit routings for approval by the Commissioner prior to the initiation of Work. Shop drawings of the security systems conduit routing shall be coordinated by Security Contractor with fire wall construction, mechanical duct work, structural components, fire protection, and plumbing.

3.7 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 IDENTIFICATION FOR SECURITY SYSTEMS

A. Identify ALL system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.

C. All permanent labels must be durable and legible and suited for long term use in the environments in which they will be located. Labels shall be preprinted or computer-printed type. Handwritten labels are unacceptable unless approved by Vassar College.

D. Label all equipment, enclosures, cables, terminations and any other components using unique identifiers.

E. Labeling scheme for all communications systems is subject to prior approval by Vassar College.

F. All cables shall be color coded and tagged consistently. Transposing or changing color coding of conductors shall not be permitted. Conductor identification shall be provided within each enclosure where a tap, splice or termination is made, and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking will not be accepted. Marking shall be an approved permanent type utilizing an approved method. Tagging devices shall be approved and shall be permanent, not subject to inadvertent separation. All conductors at control consoles shall be bundled, neatly fanned out, and tagged. Cables and wires shall be tagged to clearly indicate their electrical characteristics, circuit number and panel designation. Tagging shall be such that several conductors may be disconnected and reconnected without the use of drawings.

3.9 CLEAN, SQUARE INSTALLATION

A. All equipment shall be clean and free of paint and other defacing materials. All installations shall be square and plumb. Take care that other trades do not deface equipment and do not move equipment out of square and plumb.

3.10 ELECTRICAL POWER

A. High Voltage Power:

1. The Electrical Contractor shall furnish and install wiring, conductors, conduit, and termination for the supply of power to security system components. Except for the interconnection into the door hardware furnished devices, it shall be the responsibility of the Security Contractor to furnish and install all low-voltage conductors and to make all final connections of same. The Security Contractor shall provide the Electrical Contractor with complete information regarding high voltage power requirements.

B. Low Voltage Power:

1. Low voltage power shall be provided through the use of two-winding isolation-type transformers and rectifier circuits and shall supply DC voltages, where and as required. Voltage levels shall be as rated for the various systems' operational requirements. All low voltage power supplies shall be fully regulated, float type, with battery back-up, capable of supporting the operation of all equipment for a minimum of four hours. Low voltage power supplies shall be required to provide central lock power, camera power, advanced processor controller power and sensor devices power.

C. Batteries:

1. Provide backup power by dedicated batteries in remotely located system elements such as remote access control panel units. Batteries shall be sized to provide continuous stand-by operation for a minimum of four (4) hours without recharge or replacement.

3.11 TESTING

A. General: Verify that all requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.

B. Verification by Inspection: Verification by inspection includes examination of an item and the comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the cited paragraph. Inspection may require moving or partially disassembling the item to accomplish the verification. Inspection shall be made of all equipment installations, proper functioning of all locking hardware and lock controls, mounting and wiring of electrical and signal distribution cabinets and components, and mounting and placement of sensors, VSS cameras, etc. to ensure compliance to the specifications and that the overall installation is accomplished in a professional and workmanlike manner. Vassar College quality control representative(s) and the shall have full opportunity to witness the required Security Contractor inspections or to conduct his own inspections of the installation.

C. Verification by Test and Demonstration: Verify by formal demonstrations or tests that the requirements of this Specification have been met.

D. Test Verification Requirements: Paragraphs 1-3 below list specific requirements which shall be verified by formal demonstration/test. Vassar College, or its authorized representatives, shall be afforded a fourteen (14) day advance notice of all subsystem demonstrations/tests. Vassar College' Representative reserve the right to witness any and/or all of the tests described below.

1. Preliminary Tests: Following installation, individually test each sensor and other components and verify the proper functioning of each component within a particular subsystem. Each subsystem shall be similarly tested until all detection zones, alarm assessment components, alarm reporting and display, and access control functions have been verified. Any deficiency pertaining to these requirements shall be corrected by the Security Contractor prior to final functional and operational tests of the system. When subsystem verification is complete, the entire system shall be tested to assure that all elements are compatible and function properly as a complete system.

2. System Operation Test: Following completion of the preliminary tests and the security system and component formal demonstrations, the Security Contractor shall conduct a formal test, to be known as the "System Operation Test", in which all components and subsystems of the security system are demonstrated to operate together as an integrated system. This test shall be performed over a continuous seventy-two (72) hour period. A testing plan and test procedures for each portion of the test shall be prepared by the Security Contractor and submitted 45 days prior to the start of any testing for approval in accordance with this Specification. Approval of the test procedures must be obtained prior to notification of testing to Vassar College or its representative. The Security Contractor shall demonstrate that the security system components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". While no formal environmental testing is required, the Security Contractor shall measure and record temperature, humidity, and other environmental parameters, and shall include this data in the test report to document the environmental parameters and the environment conditions which were encountered during the "System Operation Test".

3. Tests Upon Completion of Work: Upon completion of the Work, the system shall be subjected to complete functional and operational tests. When all required corrections have been accomplished, the system shall be retested. Vassar College Representatives shall be notified in writing fourteen days in advance of the proposed final acceptance testing and inspection date. The advance notice shall include certification that the installation is complete and operable and has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection will be accomplished in the company of the Vassar College representatives. Prior to the test date, prepare and submit for approval a complete and detailed final acceptance test check off list ("punch list"). The list shall be a complete representation of all specified functions and conditions, including contingency, priority, and abnormal modes of operation. The arrangement of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The tests shall be structured so that all sensors and controls are stimulated directly in their installed and finally adjusted positions and all audible and visual displays, signals, alarms and other responses are observed and printed. At the time of final acceptance testing all required tests shall be repeated and all defects will be corrected until the system is found to be acceptable to Vassar College Representative. A log of all test activities and results shall be maintained by the Security Contractor. Typed copies of this log shall be submitted within seven days of the testing. Final tests shall include, but not limited to the following:

   a. Test of all central CPU's, peripherals, and all panel control functions.
   b. Test all graphic control and annunciation panel functions and displays.
   c. Test electrical supervision of all input/output sensor and data communication bus circuits.
   d. Test of all alarm initiating devices.
   e. Test of remote battery and battery chargers.
   f. Test of the UPS system including a battery discharge test
   g. Test of access control system to include tie-in to fire alarm system.
   h. Complete operation tests under emergency power.
   i. Test of fiber optics signal transmission system.
   j. Visual inspection of all wiring;

k. Verification that all required submittals have been provided and have been accepted;
l. Demonstrate software and programming/reprogramming functions of all micro-processor systems.
m. Verification of systems response time.
n. Carefully plan and coordinate the final acceptance tests so that all tests can be satisfactorily completed during one continuous testing period. Provide all necessary instruments, labor and materials required for tests, the equipment manufacturer's technical representative, and qualified technicians in sufficient numbers to perform the tests within the time limits imposed by this Specification.
o. In the event that Vassar College, or authorized representative(s) are required to witness a re-test at a later date because the Security Contractor is either not adequately prepared to conduct the acceptance tests or because the systems being tested are failing such tests, which shall be solely determined by Vassar College representatives witnessing the tests, the costs of witnessing additional tests (based on time and materials at the established rates of Vassar College representatives) shall be borne exclusively by the Security Contractor. In such an event, the Security Contractor shall directly compensate Vassar College representatives witnessing the tests; compensation shall be provided within thirty calendar days of such, and all, additional tests.
p. Although successful completion of the final acceptance test has been completed, the security system shall not be considered accepted until it is determined that the complete security system is continuously trouble-free and operational, in a manner satisfactory to Vassar College, for at least a seven-day period following final acceptance testing. A print-out of the system's activity log will be accepted as proof of compliance with this requirement. In the event that the system fails this operational test, make the necessary adjustments and the seven-day period will restart from the beginning. If the system fails to complete this operational test for four (4) consecutive seven-day restarted test periods, the system shall be considered inoperable and unacceptable. Make all necessary repairs, adjustments, and/or replacements, at his cost. When all adjustments have been completed and after proper notice has been given, the complete acceptance test will be re-performed and witnessed from the beginning. The Security Contractor shall be liable for all expenses for witnessing the retest as specified above. Repeated unsatisfactory operation and chronic system failures shall be considered cause for the complete system removal and replacement by Vassar College. In this event, the Security Contractor shall be liable for all expenses and damages incurred, including legal fees and court costs.

4. Reliability/Maintainability Data: Record hours of component, subsystem and system operation, together with failure and repair data. This information shall be incorporated into the System Test Report to be submitted.

3.12 MAINTENANCE AND OPERATING INSTRUCTIONS

A. Prior to completion of the workt, provide field operating instructions with respect to operation functions and maintenance procedures for the equipment and systems installed. Prepare six (6) copies of maintenance and operating instruction manuals prior to application for final payment. Organize operating and maintenance data into suitable sets of manageable size.

B. All equipment provided under this Section of the Specifications shall be placed in operation and shall function continuously in an operation test for a period of one week, without shut down due to mechanical failure.

C. Prior to scheduling the project final inspection and after completion of the entire installation period, provide all work required to adjust all controls, and all maintenance to place the systems in operation to meet the requirements of this Section of the Specifications and Contract Documents.

D. Provide operating, service, maintenance instruction manuals containing replacement data for the equipment which will require operating, maintenance or replacement and one copy of this literature shall be available during the instruction of the operating personnel while the others are checked for completeness.

E. Sufficient advance notice shall be given to Vassar College designated operating personnel for the specific instruction period. Upon completion of instruction, obtain from the representative(s) written verification that the above mentioned instruction has been performed. Such verification shall be forwarded to Vassar College.

F. Each copy of the approved operating and maintenance manual shall contain copies of approved shop drawings, equipment literature, cuts, bulletins performance charts, pump curves, details, equipment and Commissionering data

sheets and typewritten instructions relative to the care and maintenance for the operation of the equipment, all properly indexed and bound in a hard back three ring binder. Fly sheets shall be placed before instructions covering each section. The instruction sheets shall be in 8 1/2 inches by 11 inches with large sheets of drawings folded in neatly. Each manual shall have the following minimum contents:

1. Table of Contents
2. Maintenance
    a. Maintenance and Lubricating Instructions
    b. Replacement Charts
    c. Preventive Maintenance Recommendations
    d. Trouble-shooting Charts for Equipment Components
    e. Testing Instructions for each Typical Component
    f. System Draining and Filling Instructions
    g. Two typed sets of charts indicating equipment tag number, location of equipment, specific equipment service, greasing and lubricating requirements as recommended, lubricant type and intervals of lubrication.
    h. Two types sets of instructions for ordering spare parts. Each set shall include name, telephone number and address of where they may be obtained.
3. Manufacturer's Literature
    a. The equipment for which shop drawings have been submitted and approved.
    b. Wiring Diagrams
    c. Installation Drawings
    d. Manufacturer's Representative and Contract Information
    e. Guarantees

3.13 CLEANING AND ADJUSTING

A. Subsequent to installation, clean each system component of dust, dirt, grease or oil incurred or accrued from other project activities, and prepare for system activation by manufacturer's recommended procedures for adjustment, alignment or synchronization.

B. Each component shall be prepared in accordance with the appropriate provisions of the component's installation, operations and maintenance manuals.

C. Any damage caused by the Security Contractor to parts of the building, its finish, or furnishings, shall be repaired by Security Contractor at no increase in Contract costs.

D. All items of equipment shall be thoroughly inspected and any items dented, scratched or otherwise damaged, in any manner, shall be replaced or repaired and painted to match the original finish. All items so repaired and refinished shall be brought to the attention of VASSAR’s Representative for inspection and approval.

3.14 SPECIAL TOOLS

A. Provide any and all special tools, recommended by the manufacturer of items furnished, noted as not being commonly available.

3.15 CERTIFICATES OF APPROVAL

A. Upon completion of the work, furnish to Vassar College Representative in duplicate, certificates of inspection and/or approval from state and local inspection authorities having jurisdiction indicating the installed systems compliance to their requirements.

END OF SECTION

SECTION 28 10 00 - ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The following documents apply to all required work for the Project: (1) the Contract Drawings, (2) the Specifications, (3) the General Conditions.

B. General Conditions

C. Division 08 Section “Door Hardware”

D. Division 26 Section “Grounding and Bonding for Electrical Systems”

E. Division 26 Section “Hangers and Supports for Electrical Systems”

F. Division 26 Section “Raceway and Boxes for Electrical Systems”

G. Division 27 Section “Communications Horizontal Cabling”

H. Division 27 Section “Communications Equipment Room Fittings”

I. Division 27 Section “Communications Connecting Cords, Devices and Adapters”

J. Division 28 Section “Common Work Results for Electronic Safety and Security”

1.2 SUMMARY

A. This section describes the components that shall comprise the Access Control and practices to be used when installing them. All information herein is intended to present minimum standards of performance, quality and construction.

B. The system shall include all hardware and software required for a complete and fully functional system, whether specified herein or not.

C. Section Includes:

1. Access Control System (ACS)
    a. Software
    b. Electromechanical Guest Room Locks
    c. Remote / Elevator Controller devices
    d. Field Devices
    e. Cabling and Power Supplies
2. Coordination with:
    a. Door Hardware Vendor
    b. Fire Alarm Vendor
    c. Elevator Vendor
    d. Other Trades

1.3 ABBREVIATIONS AND DEFINITIONS

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.4 STANDARDS AND CODES

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.5 SUBMITTALS

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.6 SUBSTITUTIONS, DEVIATIONS AND CHANGES

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.7 TRAINING

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.8 QUALITY ASSURANCE

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.9 PROJECT CONDITIONS

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

1.10 COORDINATION

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ACS

1. Assa Abloy
2. No substitutions

2.2 SYSTEMS DESCRIPTION

A. This section outlines the requirements for the Access Control System (ACS). All information herein is intended to present minimum standards of performance, quality and construction.

B. Provide and install systems which shall include all hardware and software required for a complete and fully functional system, whether specified herein or not.

C. Coordinate the installation of the door/frame security package with the Door Hardware Section of project specifications. Generate a spreadsheet identifying all the doors to receive electronic security devices and validate that the door hardware submittal and doors submittal shall support the required security functions. Should a conflict in function be identified, the security contractor shall alert the Commissioner. The contractor shall be responsible to ensure that the door and door hardware supplier is aware of the required security functions.

D. Electronic locking devices will be provided under the Door Hardware Section.

E. Coordinate the installation with all other trades.

F. Provide complete initialization of the system's hardware and software. Consult with Vassar College to determine requirements prior to initialization

G. Coordinate the security requirements of this Section with all other trades.

H. FUNCTIONAL REQUIREMENTS

I. The ACS shall manage the guest room access, elevator access & lobby doors.

2.3 SYSTEM PARAMETERS

A. Provide all required system components and accessories for the devices shown on drawings.

B. In addition, the system shall be scalable to allow addition of future devices. Provide 5% spare capacity.

2.4 SYSTEM PERFORMANCE CRITERIA

A. Within the context of the overall system performance previously described, the system components shall be designed to operate as described herein.

1. Modularity: Provide components designed for modular increase or decrease of system capability by installation or removal of plug-in modules. System components shall be designed to facilitate modular subassembly and part replacement.
2. Reliability: Provide only new, unused components free from flaws or imperfections, which are in current manufacturing production. Components shall be manufactured to meet all the requirements specified herein and shall be free from characteristics or defects which affect the appearance or which might affect the serviceability or render the equipment unsuitable for the intended purpose. The workmanship shall be of superior quality. The MTBF for any sensor component shall not be less than five-thousand (5000) hours. Provide components designed for continuous operation. Electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL seven-hundred-ninety-six (UL-796). Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. Power-dissipating components shall incorporate safety margins of not less than twenty-five (25) percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity. Light duty relays and similar switching devices shall be solid-state type or hermetically sealed electro-mechanical type.
3. Maintainability: The components shall be capable of being maintained using commercially available standard tools and equipment. Components shall be so arranged and assembled that they are readily accessible to maintenance personnel without compromising the defeat resistance of the various security subsystems.
4. Availability: Provide products and services available within the project schedule established for the Contractor's Work. Delays due to a manufacturer's inability to deliver the required products and materials within the established schedule shall be regarded as a default in the Agreement between the Contractor and Vassar College, subject to the terms and conditions within this Agreement governing default or terms of comparable intent.

2.5 FRONT DESK EQUIPMENT AND SOFTWARE

A. System Server: Provide a server with monitor, mouse, and keyboard, and RFID encoder.

1. Server Requirements:

a. Operating System: Microsoft Windows™ 7/8/Server 2008/2012. 32 or 64 bit.
b. 4 GB RAM
c. 80GB HDD
d. Ethernet Network Card
e. Two (2) Serial ports.
f. Four (4) USB ports.

B. System Software: Provide software compatible with operating system provided with the server and LAN networking. Provide software with TCP/IP addressing capabilities, and capability to interface with the major Property Management System (PMS) and Point of Sale (POS) systems.

1. Software System Features:
a. 10,000 unique user ID's.
b. 250 User groups.
c. Up to 99 Check-in stations.
d. Unlimited timetables.
e. PMS Interface through TCP/IP, Serial RS-232.

C. Card Encoders: Provide RFID MIFARE encoders compatible with the following frequencies: ISO 14.443A, ISO 14.443B, and ISO 15.693. Provide system capable of supporting up to 99 check-in stations and being directly

connected into the LAN network, using TCP/IP addressing or the PC serial port. Provide two (2) stations for properties up to 300 rooms, and three (3+) stations for properties over 300 rooms.

D. Lock Programmers: Provide system compatible, password controlled programmer using Windows OS application. Audit Trail information shall be viewable on the lock programmer. Provide Lock Service PC with emergency lock override capabilities.

E. Offline System Option: This facility will operate with offline lock programming and control. No online system components or lock end-nodes are required.

F. Online Ready System Option: This facility will operate with offline lock programming and control. No online system components are required, but provide lock end-nodes for possible future addition of an online system.

G. Acceptable Manufacturers:

1. VingCard (VI) – VisiOnline Software

2.6 ELECTROMECHANICAL GUEST ROOM MORTISE LOCKS

A. Mechanical Requirements: Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel deadbolt. Provide a panic release where the deadbolt and latch are simultaneously retracted by the inside handle for easy egress in emergency situations. Auto deadbolt option where both the latch and deadbolt lock the door independently from each other shall be available. Where specified, supply locksets with an optional mechanical override cylinder. Register use of mechanical key override in the lock memory for audit trail.

B. Electrical and Reader Requirements: 13.56MHz RFID readers which are compatible with ISO 14.443A (MIFARE), ISO 14.443B, ISO 15.693, NFC (Near Field Communication), and Bluetooth Low Energy (BLE) standards. Lock functioning is motorized and powered by standard AA batteries. Mechanisms are to be within the lock case and not accessible from the outside. Provide flash RAM memory and a 2000 event audit trail.

C. Locks are of two piece construction with separate lever/rose and slim line reader. One piece full escutcheons will not be accepted.

D. Provide the necessary end-nodes if an Online or Online Ready system is being utilized.

E. Acceptable Manufacturers:

1. VingCard (VI) – Signature RFID.
2. No Substitution – Facility Standard

F. Coordinate with the Door hardware vendor.

2.7 ELECTROMECHANICAL EXIT DEVICES

A. Mechanical Requirements: ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices. Devices must be available in both rim and vertical rod designs. Provide device sizes to suit door width and height.

B. Electrical Requirements: Match the reader technology for the guest room locks. Functioning is motorized and powered by standard AA batteries. Provide flash RAM memory and a 2000 event audit trail.

C. Outside lever trim only. Exit device is specified in section 087100. Rim or Vertical Rod Panic Interface as indicated in hardware sets.

D. Acceptable Manufacturers:

1. VingCard (VI) – VC3000ED Series.
2. No Substitution – Facility Standard.

E. Coordinate with the Door hardware vendor.

2.8 REMOTE CONTROLLERS

A. Match the reader technology for the guest room locks. 24VDC hardwired, constructed of weather resistant electronics suitable for either indoor or outdoor applications. Used at locations which cannot accept mortise locks or

exit devices such as parking garage gates, pool entrances, elevators, and automatic doors. Provide a 24VDC 2 amp power supply and relay box for each controller. The maximum distance between the controller and the relay box is 60 feet.

B. Acceptable Manufacturers:

1. VingCard (VI) – Remote Controller RFID.

2.9 ELEVATOR CONTROLLERS

A. Match the reader technology for the guest room locks. Provide one controller per elevator panel. If multiple floors are being controlled provide the required multi-output control boards. Provide a 24VDC 2 amp power supply and relay box for each controller.

B. Acceptable Manufacturers:

1. VingCard (VI) – Elevator Controller RFID.

2.10 KEYCARDS

A. Provide RFID keycards as required by the access control system specified herein. Provide a second layer of anti-cloning encryption to eliminate card duplication. Cards are to be capable of resisting tearing, bending, scratching, and moisture.

B. Guest Card Memory: UL (Ultralight) 256k.

C. Guest Card Memory: MIFARE 1K for Point of Sale (POS) and parking gate interfaces.

D. Staff Card Memory: MIFARE 4K.

E. Quantity: Minimum of five guest cards per guest room. Minimum of three staff cards per estimated number of staff members.

F. Provide customized card logo as directed by the property owner.

G. Acceptable Manufacturers:

1. VingCard (VI).
2. No Substitution – Facility Standard.

2.11 CABLES

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security.

2.12 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Insulators shall electrically isolate bus bars from the wall, or other mounting surfaces, thereby controlling the current path.

C. Provide required stainless-steel hardware to fasten the two-hole ground lugs to the bus bar.

2.13 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. All materials shall be installed as per the manufacturers’ instructions, unless noted otherwise.

B. Comply with NECA 1.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Comply with NECA 1, "Good Workmanship in Electrical Contracting."

E. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”.

F. All equipment shall be installed according to manufacturers’ instructions.

3.2 GENERAL

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

E. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

F. Record setup data for control station and workstations.

G. For each Location, record setup of Controller features and access requirements.

H. Propose start and stop times for time zones and holidays, and match up access levels for doors.

I. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.

J. Assign action message names and compose messages.

K. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.

L. Prepare and install alarm graphic maps.

M. Develop user-defined fields.

N. Develop screen layout formats.

O. Propose setups for guard tours and key control.

P. Discuss badge layout options; design badges.

Q. Complete system diagnostics and operation verification.

R. Prepare a specific plan for system testing, startup, and demonstration.

S. Develop acceptance test concept and, on approval, develop specifics of the test.

T. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

3.3 CABLING

A. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

B. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

C. Install cables without damaging conductors, shield, or jacket.

D. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

E. Install end-of-line resistors at the field device location and not at the Controller or panel location. All wiring where exposed shall be installed in conduit, minimum 3/4" or larger, in accordance with NFPA 70 and local codes.

F. All cables shall be terminated and connected onto termination strips. Conductors at all junction points or termination shall be tagged with conductor identification.

G. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

H. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

I. RS-232 Cabling: Install at a maximum distance of 50 feet.

J. RS-485 Cabling: Install at a maximum distance of 4000 feet.

K. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.

2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.

3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.

4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

3.4 ELECTRICAL POWER

A. All AC power feeds to the system shall be installed in conduit separate from the data bus communication and low voltage control cables. The 240 VAC input power shall be furnished and installed by the Electrical Contractor. The Security Contractor shall be responsible for coordinating his requirements with the Electrical Contractor.

B. The Security Contractor shall furnish and install, in accordance with the manufacturer's instructions, all interconnect wiring, and equipment necessary for the erection of a complete system as described herein and shown on the drawings. All wiring termination, except 240 VAC power inputs and above door finish hardware device inputs, shall be the responsibility of the Security Contractor.

3.5 SYSTEM SOFTWARE

A. Coordination with Vassar College required for system configuration and programing. Use common “System’s Operational Protocol” for programming Security Systems for Vassar College facilities, thereby facilitating training and trouble shooting by Vassar College staff.

B. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Vassar College.

C. The software shall be entered into the system computer systems and debugged. The Contractor shall be responsible for documenting and entering the initial database into the system. The Contractor shall provide the necessary blank forms with instructions to fill in all the required data information that will make up the database. The database shall then be reviewed by the Contractor and entered into the system. Prior to full operation, a complete demonstration of the computer real time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.

3.6 TESTING AND SYSTEM ACCEPTANCE

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”.

3.7 DEMONSTRATION

A. Refer to Division 28 Section “Common Work Results for Electronic Safety and Security”.

B. Engage a factory-authorized service representative to train Vassar College maintenance personnel to adjust, operate, and maintain security access system. Refer to Division 01 Section "Demonstration and Training"

C. Develop separate training modules for the following:

1. System managers to maintain and update software and databases: VisiOnline Software training course, or approved equal
2. Security staff monitoring the system
3. Maintenance staff

END OF SECTION

SECTION 28 31 00

ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary conditions and Division-1 specification sections, apply to work of this section.

B. Division 26, Basic Electrical Materials & Methods apply to work specified in this section.

C. Division 26 “Electrical Identification” apply to work in this section for labeling of conduit and equipment.

D. Related work specified in other divisions of these specifications.

1. Installation of duct type smoke detectors.
2. Control wiring from Fire Alarm Control equipment to mechanical fans, dampers, control equipment both low voltage and line voltage and all other control wiring associated with mechanical equipment.

E. Secure permits and approvals prior to installation.

F. Prior to commencement and after completion of work notify Authorities Having Jurisdiction.

G. Submit letter of approval for installation before requesting acceptance of system.

1.2 SUMMARY

A. Provide a complete and coordinated Class A wiring, fire management system in accordance with the contract documents.

B. System shall be compatible and integrated into existing campus SAFECO ALARM SYSTEMS INC .Contact Mr. Paul Sistare at 845-338-4440. System shall be installed and warrantied under direct supervision of SAFECO and Mr. Paul Sistare.

C. Any fire alarm devices, wiring etc., not indicated on the drawings, but required by the Authority Having Jurisdiction and Fire Department, shall be provided as part of this specification. As minimum, an additional 25 audio/visual alarms 25 smoke detectors and 25 addressable interface devices shall be included in price including labor, circuitry and programming. Devices shall be placed as directed in field.

1.3 RELATED WORK

A. The Contractor shall coordinate work in this Section with all related trades. Work and/or equipment provided in other Sections and related to the alarm system shall include, but not be limited to:

1. Fire/Smoke Dampers wiring and connections shall be provided under this contract. Refer to mechanical drawings for quantities and locations.

2. Sprinkler waterflow and supervisory switches shall be furnished and installed by the plumbing contractor, but wired and connected by the electrical contractor. Modification of existing sprinkler devices to accommodate monitoring by the new Sprinkler system shall be the responsibility of the alarm system installing contractor (if applicable).

3. Duct smoke detectors shall be furnished, wired and connected by the electrical contractor. The HVAC contractor shall furnish necessary duct opening to install the duct smoke detectors.

4. New air handling and smoke exhaust system fan control circuits and status contacts to be furnished by the HVAC control equipment.

5. Elevator recall control circuits to be provided by the elevator control equipment. Modifications to the existing elevator controls to accommodate ANSI A17.1 shunt trip activation shall be provided by the elevator controls contractor. Any shunt trip circuit breakers and related wiring required for ANSI A17.1 compliance shall be provided by the electrical contractor (see power riser for more details).

6. Dry pipe/deluge sprinkler system release valve control circuits and supervision contacts shall be provided by the dry pipe/deluge sprinkler system control equipment (if applicable).

7. Conduit: Section 26 05 33.

8. Wire and Cables: Section 26 05 13.

9. Installing dedicated outgoing RJ-31X telephone lines (2) in rigid conduit shall be the responsibility of the Installing Electrical Contractor. Establishment of central station monitoring account shall be the responsibility of the fire alarm equipment vendor. Central station subscription information shall be provided by the customer.

1.4 SUBMITTALS

A. Procedure - prepare and make submittals listed in accordance with Division 1, “Submittals” as required by Local Department of Fire.

B. Provide list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer’s part number, the description of the part, and the part number of the manufacturer’s product datasheet on which the information can be found.

C. Provide description of operation of the system (Sequence of Operation), similar to that provided in Part 2 of this Section of the Specifications, to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment. The sequence of operation shall be project specific, and shall provide individual sequences for every type of alarm, supervisory, or trouble condition that may occur as part of normal or off-normal system use.

D. Product Data - submit manufacturer’s specifications, recommendations, and installation instruction for use intended. The data shall include but is not limited to the following:

1. Control panels and remote data gathering panels.
2. Cabinets
3. Manual stations
4. Batteries
5. Battery charger
6. Smoke sensors
7. Installer’s training history
8. Visual alarms
9. Audio/visual alarms
10. Addressable interface devices
11. Central processing unit
12. Wiring conductors

13. Wire connectors
14. Thermal sensors
15. Electromagnetic door hold-open devices
16. Remote alpha numeric LCD annunciators with control capabilities.
17. Manufacturer's recommended calibrated test method for smoke sensors and smoke detectors.
18. Include Underwriters Laboratories or Factory Mutual listing cards for equipment provided.

E. Provide manufacturer's printed product data, catalog cuts and description of any special installation procedures. Poorly photocopied and/or illegible product data sheets shall not be acceptable and shall be rejected. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.

F. Provide manufacturer's operator's instruction manual for specified system.

G. Provide samples of various items when requested.

H. Provide copy of New York License to perform such work.

I. Provide copies of NICET Level II Fire Alarm certifications for the two (2) technicians assigned to this project.

J. Drawings

1. Detailed drawings for the fire alarm system shall consist of illustrations, schedules, performance charts, battery calculations, point lists, instructions, diagrams, sequence of operation, and complete detailed drawings of the fire alarm system.
2. A descriptive index of drawings in the submittal with drawings listed in sequence by drawing number.
3. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
4. Floor plans drawn to a scale not less than 1/8-inch equals 1 foot which clearly show locations of devices, equipment, risers, panels, electrical power connections, approximate location of conduit runs, and other details required to clearly describe the proposed system.
5. Location of control panels, detectors, supervisory switches, manual pull stations, visual/audible alarms and electrical devices. Clearly and completely indicate the function of the control panel and devices. Indicate conduit routing and sizes, and the number of conductors contained in each. Indicate points of connection and terminals used for electrical field connections in the system, with a wiring color code. Indicate termination points of devices and indicate the interconnection of modules required for proper operation of the system. Indicate interconnection between modules and devices. Control diagrams shall be supplemented with a narrative description of the system. Point-to-point wiring diagrams shall indicate control panel wiring and make and model of devices and equipment. Signal circuit diagrams shall show current draw and load by device and by circuit.
6. Device riser diagram shall individually depict all control panels, annunciators, addressable devices, and notification appliances. Riser diagrams shall include a specific, proposed point descriptor above each addressable device. Riser diagrams shall include a specific, discrete point address that shall correspond to addresses depicted on the device layout floor plans. Drawing shall provide wire specifications, and wire tags shown on all conductors depicted on the riser diagram. All circuits shall have designations that shall correspond with those require on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.
7. Device typical wiring diagram drawing(s) shall be provided which depict all system components, and their respective field wiring termination points. Wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided. End-of-line resistors (and values) shall be depicted.

K. Design Data

1. Battery standby power requirements calculations.
2. Battery calculations shall be provided on a per power supply/charger basis. These calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements (which reflect a 20% DEGRADE, for 24 Hour supervisory, 45 minute alarm operation). Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws. Failure to provide these calculations shall be grounds for the complete rejection of the submittal package.

L. Field Test Reports

1. Preliminary and acceptance tests.
2. Include the control panel and initiating and indicating devices, a unique identifier for each device with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information.

M. Records Drawings

1. Upon completion, and before final acceptance of the work, submit a complete set of CAD generated as-built drawings for the fire alarm system, including components and any other associated appurtenances. Include as-built circuit diagrams complete with conductor color codes and a listing of initiating device locations and fixing voltage for each. Submit a minimum ten of 11 x 17 inch reproducible as-built drawings with title block similar to contractor drawings, and provide CAD diskettes of entire project. Submit as-built drawings in addition to the record drawings required by Division 1, “Operation and Maintenance Data”.
2. List of FACP alphanumeric address names
3. Request for formal inspection and tests
4. When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests.

N. Operation and Maintenance Manuals

1. Fire alarm control panel
2. Smoke and thermal sensors
3. Interface and control modules
4. Submit in accordance with Division 1, “Operation and Maintenance Data”. Include current unit prices and source of supply for parts list, and a list of parts recommended by the manufacturer to be replaced after one year and three years of service. Include in the fire alarm control panel, full and comprehensive manufacturer’s repair and service manuals.

O. See section 3.3 F. Documentation and Training for other documents related to this section.

1.5 QUALITY ASSURANCE

A. Qualifications the manufacturer’s authorized distributor must substantiate that within a 50 mile radius of the job site, there is an established agency which stocks a full complement of parts and offers full service during normal working hours on all equipment to be furnished and that the agency will supply parts without delay and at a reasonable cost.

B. Qualifications of Installer: Prior to installation, submit data for approval showing that the Contractor has successfully installed addressable, analog intelligent interior fire alarm systems of the same type as specified herein, or that the Contractor has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months. Submit names and phone numbers of points of contact at each site.

C. Codes and Standards: Except as modified by governing codes and where more stringent standards are specified by the contract documents, comply with the latest applicable provisions and the latest recommendations of the following:

1. All equipment shall be UL listed for its intended use.
2. National Electric Code, Article 760.
3. National Fire Protection Association Standards: NFPA72 and NFPA 101.
4. Local and State Building Codes and the Local Authorities Having Jurisdiction.
5. MEA / BSA
6. Underwriters Laboratories Inc.: The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:

UL 864/UOJZ, APOU	Control Units for Fire Protective Signaling Systems.
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Applications.
UL 217	Smoke Detectors Single Station.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 228	Door Holders for Fire Protective Signaling Systems.
UL 464	Audible Signaling Appliances.
UL 1638	Visual Signaling Appliances.
UL 38	Manually Activated Signaling Boxes.
UL 346	Waterflow Indicators for Fire Protective Signaling Systems.
UL 1971	Standard for Signaling Devices for the Hearing Impaired
UL 1481	Power Supplies for Fire Protective Signaling Systems.
UL 1711	Amplifiers for Fire Protective Signaling Systems.

7. Americans with Disabilities Act (ADA)
8. International Standards Organization (ISO): ISO-9001
9. Local and City Codes.

D. Federal Specifications Compliance: Comply with FED-STD-595, “Colors used in Government Procurement”.

E. Guarantee - all components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months upon acceptance. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within 50 miles from the job site.

F. Testing - conduct a total system test for Architect/Engineer and Local Fire Department. Tests shall include as a minimum.

1. Verify operation of all manual pull stations and detectors.
2. Verify line supervision of each initiating and indicating circuit.
3. Verify the Class A operation of each initiating circuit.
4. Verify operation of all indicating devices.
5. Verify operation of all alarm initiated function.
6. Perform smoke test(s) as directed by the Local Fire Department. Provide electricians, and factory representatives to perform as many tests as required to approve system. The Engineer, Owner and Architect shall be advised a minimum of five working days before each test.

G. All equipment provided as part of this section shall be the product of a single fire alarm equipment manufacturer.

H. Equipment and devices shall be from a manufacturer who has been manufacturing similar products for a minimum of 5 years. Furnish materials and equipment that are current products of one manufacturer regularly engaged in the production of such equipment.

I. Regulatory Requirements

1. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

J. Requirements for Fire Protection Service

1. Equipment and material shall have been tested by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

K. Standard Products

1. Materials and equipment shall be standard new products of a manufacturer regularly engaged in the manufacturer of such products. Select material from one manufacturer, and not a combination of manufacturers, for any particular classification of materials.

L. Modification of References

1. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; interpret reference to "authority having jurisdiction".

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

1.7 SPARE PARTS

A. Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping or tagging. Furnish the following:

1. Four keys or tools for resetting manual systems.
2. Four keys for locks of control panels or cabinets.
3. Three (bases and heads) of each type smoke (area and duct) and thermal sensors.
4. Three of each type monitor module.
5. Three of each type control module.
6. Three fuses of each type provided. Spare fuses shall be mounted in the fuse holder located inside each control panel.
7. One of each type audio/visual device.
8. One of each type visual device.

PART 2 - PRODUCTS

2.1 SYSTEM DESIGN

A. Acceptable Manufacturers:

1. SAFECO ALARM SYSTEMS INC
2. All products used shall be of a single manufacturer. Submission of notification appliances, auxiliary relays, or documentation from other than a single manufacturer shall not be acceptable and will be grounds for immediate disapproval without comment.

3. The Sprinkler / Smoke Detection System supplied under this specification shall be a microprocessor-based. All Control Panel Assemblies and connected Field Appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as compatible to ensure that a fully functioning Life Safety System is designed and installed.

B. Scope :

1. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performing all operations in connection with the installation of the multiplex addressable Fire Alarm System (Class A) as shown on the drawings, as hereinafter specified, and as directed by the architect/engineer. It shall be complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer.
2. The Fire Alarm System shall consist of all necessary hardware and software equipment to perform the following functions:
   a. Fire Alarm and Detection Operations.
   b. Two-way Supervised Voice Communication Operations.
   c. One-way Supervised Automatic Voice Alarm Operations.
   d. Remote Manual and Automatic Control of elevators, all Smoke Control Related Fan Systems, remote monitoring of sprinkler, fire pump, and emergency power systems.
   e. Interface to the public address speaker system for the seating bowl.
   f. Interface to Division 23 smoke control equipment with appropriate outputs, controls and graphics.
3. Each item of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. The Control Equipment for all Systems shall be listed under UL category UOJZ as a Single Control Unit.
4. The complete installation shall conform to the applicable sections of NFPA-72, NEC 76, Life Safety Code 101, and Local authorities having jurisdiction.
5. Nodes as defined for this specification shall be intelligent, microprocessor based devices that connect to, and handle network communications.
6. By programmable selection at each node:
   a. The specific detail information of any point connected to any node in the network may be made accessible (declared public) to the network.
   b. Points within each node shall be able to be grouped by area, type of device, type of function, or any other user selectable category, and custom labeled as a point list. A point list shall be acted upon as though it was a point for purposes of interaction with the node custom control program. Detail information shall not burden the point list messages, only the quantity and type of status shall be broadcast into the network.
7. The fire alarm system shall be provided with the primary monitoring host computer system for alarms, trouble, and supervisory indication located as shown on the construction documents. This host shall be U.L. listed for use with the fire alarm system. The host system shall be connected to the fire alarm control panels utilizing an RS-485, BacNet Level II, or equivalent network protocol on a twisted pair communication bus network.
8. Survivability: When wiring connecting the FSCS to any remote mounted controlling device exceeds 100 feet; the wire shall be 2-hour rated in addition to being in conduit.

9. All locally required Sprinkler – Smoke Detection system peripherals, placards, pull station white stripe plate, riser diagram, etc. shall be included in the system price.

C. Alarm System

1. Furnish and install a fully field programmable/addressable analog fire detection system. The System shall determine the number and types of modules installed, the number of analog addressable loops, and all installed devices. It shall determine the type of device and the device number. The System shall use Style 4 (Class A) signaling line circuits and Style Z (Class A) indicating appliance circuits with individual device

supervision and annunciation, primary and secondary supervision, and interfaces to the public address system (furnished by others). Include control panels, central processing unit, microphone, signal zone selectors, manual pull stations, smoke sensors, thermal sensors, addressable input interface devices, control and isolation devices, analog/addressable loop modules, audio/visual devices, visual devices, wiring, connections to devices, outlet boxes, junction boxes, and other necessary material for a complete operating system. System shall allow for loading or editing special instructions and operation sequences as required. System shall be site programmable to accommodate and facilitate expansion or changes. System shall be capable of generating the programming necessary to establish a fully functional general alarm system upon initialization. Software operations are to be stored in a non-volatile programmable memory. Loss of primary and secondary power shall not erase the instructions stored in memory. Selective input/output control functions based on ANDing, Oring, NOTing, timing and special coded operations shall be incorporated in the resident software programming of the system.

D. Job Site Changes

1. To accommodate and facilitate job site changes, initiating and indicating circuits shall be individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching circuit or an alarm verification circuit.

E. Operations

1. Display
   a. Under normal condition, front panel shall display a “SYSTEM NORMAL” or equivalent message and the current time and date.
2. Sequence of Operation
   a. The system shall identify any off normal condition and log each condition into the system database as an event.
      (1) The system shall automatically display on the control panel Liquid Crystal Display the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.
      (2) The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event; alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.
      (3) For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 40 character custom user description.
      (4) The user shall be able to review each event by simply selecting scrolling keys (up-down) for each event type.
      (5) New alarm, supervisory, or trouble events shall sound an audible signal at the control panel.
   b. Operation of any alarm-initiating device shall automatically:
      (1) Update the control/display as described above (a.(1)).
      (2) Sound all audible appliances in a Temporal-3 Pattern. ALL AUDIBLE APPLIANCES SHALL BE SYNCHRONIZED WITH EACH OTHER WHEN TWO OR MORE HORNS CAN BE HEARD. Audible devices shall have the ability to be silenced.
      (3) Activate all strobe appliances throughout the facility. ALL STROBE APPLIANCES SHALL BE SYNCHRONIZED WITH EACH OTHER, IN ANY LOCATION WITH TWO OR MORE DEVICES IN A COMMON FIELD OF VIEW. Visual devices shall be non-silenced unless the system is successfully reset.
      (4) Operate control relay contacts to shutdown all HVAC units serving the floor of alarm initiation.
      (5) Operate control relay contacts to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, operate control circuits contacts to return all elevators to the floor above or to a level as directed by the local fire department.

(6) Operate control relay contacts to release all magnetically held smoke doors throughout the building.
(7) Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.
(8) Transmit an alarm condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).

c. Elevator smoke and heat detector sequences shall comply with the ANSI A17.1 requirements for main/alternate floor recalls, and shunt trip activations.

d. Activation of a sprinkler supervisory initiating device shall:(if applicable)
(1) Update the control/display as described above (a.(1)).
(2) Transmit a supervisory condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).
(3) Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.

e. The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or disarrangement of system wiring and shorts across alarm signaling wiring shall automatically:
(1) Update the control/display as described above (a.(1)).
(2) Transmit a trouble condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).
(3) Visually and audibly annunciate a general trouble condition, on the remote annunciator panels. The visual indication shall remain on until the trouble condition is repaired.

F. Primary Power

1. Provide normal and/or emergency power as per fire alarm detail on drawings.

2. Obtain primary power 208/120 VAC 50/60hz, from main service switchboard, and emergency power from emergency generator utilizing fuse switches as indicated in fire alarm power supply detail. Primary and emergency power sources shall be identified FIRE ALARM SYSTEM with a red and white engraved plastic sign permanently affixed to the face of the cutout. Provide multiple fuse switch power supplies from both normal and emergency sources as required for the components furnished, including, but not limited to, fire alarm panels, transmitters for off-site reporting, etc.

G. Auxiliary Power (Secondary Power)

1. Provide for system operation in the event of normal and/or emergency power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal and/or emergency power shall be automatic and shall not cause transmission of a false alarm.
   a. Batteries
      Provide rechargeable lead acid type with sufficient ampere-hour rating to operate the system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional 5 minutes. House batteries either within the control panel or in a separate substantial steel cabinet, and finish on inside and outside with enamel paint; equip with a non corrosive base and cylinder lock keyed to match FACP. Separate cells to prevent contact between terminals of adjacent cells and between terminals and other metal parts. Locate cabinet to allow convenient viewing and servicing of the batteries. A separate cabinet shall have twice the volume of batteries it will contain. The battery cabinet, if provided, shall be identified FIRE ALARM SYSTEM BATTERY CABINET with a red and white engraved plastic sign permanently affixed to the face of the panel.
   b. Battery Charger
      Provide solid state automatic float type, capable of recharging completely discharged batteries to fully charged condition in 24 hours or less. Locate charger within the control panel or within the battery cabinet. Provide voltmeter and ammeter to indicate battery voltage and charging current.

H. Wiring

1. Each addressable analog loop shall be circuited so device loading is not to exceed 80% of loop capacity in order to leave for space for future devices. The loop shall have Class A operation.
2. Where it is necessary to interface conventional initiating devices provide intelligent input modules to supervise Class A zone wiring.
3. Each of the following types of devices or equipment shall be provided with supervised circuits as shown on the drawings but shall be typically as follows:
   a. Sprinkler Valve Supervisory Switches: Provide one (1) supervisory module circuit for each sprinkler valve supervisory switch (if applicable).
   b. When waterflow and tamper switches exist at the same location, provide one (1) dual input addressable module. When odd numbers of devices exist at a single location, provide additional single input addressable modules (if applicable).
4. Each of the following types of alarm notification appliances shall be circuited as shown on the drawings but shall be typically as follows:
   a. Audible Signals: Provide sufficient spare capacity to assure that the addition of five (5) audible devices can be supported without the need for addition control components (power supplies, signal circuit modules, batteries, etc.).
   b. Visual Signals Provide sufficient spare capacity to assure that the addition of three (3) audible devices can be supported without the need for addition control components (power supplies, signal circuit modules, batteries, etc.).
5. Each of the following types of remote equipment associated with the alarm system shall be provided with a form ‘C’ control relay contact as shown on the drawings, but shall be typically as follows:
   a. HVAC Fan Systems: Provide one (1) shutdown control relay contact for each HVAC fan system.
   b. HVAC Supply Fans: Provide one (1) shutdown control relay contact for each HVAC supply fan.
   c. HVAC Return Fans: Provide one (1) shutdown control relay contact for each HVAC return fan.
6. Provide a dedicated 24VDC circuit to feed all auxiliary relays required for inductive loads. Circuits shall be supervised via an end-of-line relay and addressable input module. Auxiliary relays shall not derive their power from the starter or load being controlled.
7. Each control or data gathering panel shall have a dedicated 20Amp-120VAC feed from the nearest available emergency panel. An appropriate fuse cut out or lockable C.B. shall be included.

2.2 UL LISTED AND APPROVED EQUIPMENT

A. Fire Alarm Control Panel Requirements:

1. The fire alarm control panel or panels and all system devices (horn-strobes, strobes, pull stations, smoke and heat detectors shall All under one label "UL listed and approved" for the use of fire alarm systems in this area of the United States of America. The operating controls shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.

B. System Controllers

1. The main controller shall be supervised, site programmable, and of modular design supporting up to 96 detectors and 94 remote modules, and two Notification Appliance Circuits (NACs). Additional support for expansion modules will add up 96 detectors and 94 modules including two additional NAC circuits. NAC's shall be convertible to power risers to serve remote multiple NAC modules for zoned signal applications. The system shall support up to five controllers connected together in a peer-to-peer topology. The cabinet shall be steel with a red finish.

C. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact. Passwords shall protect any changes to system operations.

D. The Main Controller Module shall control and monitor all local or remote peripherals. It shall support the 2-LCD Display Module, power supply, remote LCD and zone display annunciators, strip and carriage printers, and support communication interface standard protocol (CSI) devices such as color computer annunciators and color graphic displays. The annunciator port shall be capable of supporting up to 30 remote annunciators. The 2-MCMN shall provide one loop controller circuit, two notification appliance circuits, and common form 'R' contacts for alarm, supervisory, and trouble. Contact ratings shall be 24Vdc at 1A.

E. The panel shall have an interface module for remote site monitoring. The module shall have a dialer (alarm communicator transmitter (DACT)) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). The DACT shall support dual telephones lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program using a touch tone phone and password. The dialer shall be capable of transmitting up to 40 individual alarm conditions to central station.

F. The system shall have built-in automatic system programming to automatically address and map all system devices attached to the main controller. A minimum default single stage alarm system operation shall be supported with alarm silence, event silence, drill, lamp test, and reset common controls.

G. Advanced Windows-based System Definition Utility with Program Version Reporting to document any and all changes made during system start-up or system commissioning shall be used to maintain site specific programming. Time and Date Stamps of all modifications made to the program must be included to allow full retention of all previous program version data. It shall support programming of any input point to any output point. The system shall support the use of Bar Code readers to assist custom programming functions. It shall allow authorized customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms. The system program shall meet the requirements of this project, current codes and standards, and satisfy the local Authority Having Jurisdiction.

H. The system shall support distributed processor intelligent detectors with the following operational attributes; integral multiple differential sensors, automatic device mapping, electronic addressing, environmental compensation, pre-alarm, dirty detector identification, automatic day/night sensitivity adjustment, normal/alarm LEDs, relay bases, sounder bases and isolator bases.

I. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.

J. Each controller shall contain a RS232 printer/programming port for programming locally via a windows based PC or down loading through modems from a remote PC. When operational, each controller shall support a printer through the RS232 port and be capable of message routing.

K. System circuits shall be configured as follows: Addressable analog Signaling Line Circuit (SLC) loops Class A (Style 4); Initiating Device Circuits Class A; Notification Appliance Circuits Class A; Network Communications Class A; Annunciator Communications Class A.

L. Single stage operation shall be provided.

M. The system shall have a UL Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

N. The system shall support 100% of all remote devices in alarm and provide support for a 100% compliment of detector isolator bases.

O. All panel modules shall be supervised for placement and return trouble if damaged or removed.

P. The system shall have a CPU watchdog circuit to initiate trouble should the CPU fail.

Q. The system evacuation signal rate shall be temporal 3-3-3.

R. Audible notification appliances shall be affected by the control panel signal silence switch. Visual signal appliance shall not be affected by the control panel signal silence switch.

S. User Interface

The 2-LCD Display Module shall be of membrane style construction with a 4 line by 20 character Liquid Crystal Display. The LCD shall use super-twist technology and backlighting for high contrast visual clarity. In the normal mode display the time, the total number of active events and the total number of disable points. In the alarm mode display the total number of events and the type of event on display. Reserve 40 characters of display space for user custom messages. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be common control keys and visual indicators for; reset, alarm silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicators to flash the indicators when undisplayed events are available for display and turn on steady when all events have been displayed. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event “hands free”. Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.

S. Power Supplies

The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 45 minutes.

T. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 5 minutes.

U. Network alphanumeric annunciators shall be located throughout the facility as indicated on the plans. The system shall have the capacity to support five network annunciators in addition to five control panels. Each annunciator shall contain a supervised, back lit, liquid crystal with a minimum of 4 line with 20 characters per line. Where required, the annunciator shall include additional zonal annunciation and manual control without additional enclosures. The annunciator shall support full ability to serve as the operating interface to the system and shall include the following features:

Matched appearance with other system displays
Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system:

Alarm
Supervisory
Trouble
Monitor

V. Each annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm or supervisory functions on a by point or by geographic area.

W. The annunciators shall be mounted in stand-alone enclosures or integrated into the network panels as indicated on the plans.

2.3 COMPONENT DESIGN

A. Colors

1. Provide finish colors under this section in accordance with FED-STD-595.

B. Intelligent Devices—General

1. Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.
2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.

C. Intelligent Detectors—General

1. The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.
2. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total analog loop response time for detectors changing state shall be 0.5 seconds.

3. Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the analog loop controller. A red LED shall flash to display alarm status.

4. The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.

5. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.

6. Each detector microprocessor shall contain an environmental compensation algorithm which identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24 hour long term and 4 hour short term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.

7. The intelligent analog detectors shall be suitable for mounting on any Signature Series detector mounting base.

8. The Fire alarm system shall have the ability to set elevator lobby Ionization or Multi Sensing smoke detectors for alarm verification. Detector in the alarm verification mode shall indicate, by point in a text format at the main control and at the remote LCD annunciators.

D. Fixed Temperature/Rate of Rise Heat Detector

1. Provide intelligent combination fixed temperature/rate-of-rise heat detectors. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of $135^{O}F$ ($57^{O}C$) and a rate-of-rise alarm point of $15^{O}F$ ($9^{O}C$) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

E. Photoelectric Smoke Detector

1. Provide intelligent photoelectric smoke detectors. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PCI. The photo detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and be suitable for wall mount applications. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes.

2. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:

   - Temperature: 32°F to 120°F (0°C to 49°C)
   - Humidity: 0-93% RH, non-condensing
   - Elevation: no limit

F. 4D Multisensor Detector

1. Provide intelligent 4D multisensor smoke detectors. The multisensor analog detector shall use a light scattering type photoelectric smoke sensor, a unipolar ionization smoke sensor and an ambient temperature sensor to sense changes in air samples from its surroundings. The integral microprocessor shall employ time based algorithms to dynamically examine values from the three sensors simultaneously and initiate an alarm based on that data. The 4D Multisensor shall be capable of adapting to ambient environmental conditions. The temperature sensor shall self-adjust to the ambient temperature of the surrounding air and input an alarm when there is a change of 65°F (35°C) in ambient temperature. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, age and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. Separately mounted photoelectric detectors, ionization detectors and heat detectors in the same location are not acceptable alternatives. The 4D Multisensor smoke detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and suitable for wall mount applications. The 4D Multisensor shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide and air velocities up to 500 ft/min. (0-2.54 m/sec) without requiring specific duct detector housings or supply tubes.

2. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The integral heat sensor shall cause an alarm when it senses a change in ambient temperature of 65°F (35°C) or reaches it fixed temperature alarm set point of 135°F (57°C) nominal. The 4D Multisensor detector shall be suitable for operation in the following environment:

   - Temperature: 32°F to 100°F (0°C to 38°C)
   - Humidity: 0-93% RH, non condensing
   - Elevation : Up to 6,000 ft (1828 m)

G. Standard Detector Mounting Bases

Provide standard detector mounting bases suitable for mounting on North American 1-gang, 3½" or 4" octagon box and 4" square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements:

1. Removal of the respective detector shall not affect communications with other detectors.
2. Terminal connections shall be made on the room side of the base. Bases which must be removed to gain access to the terminals shall not be acceptable.
3. The base shall be capable of supporting one (1) Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

H. Combination Smoke and CO Alarms

If indicated on the project plans, provide combination 120 VAC / 9 Vdc smoke and CO alarms. The combination smoke and CO alarm shall include a relay contact that may be monitored by the smoke detection system as either a non-alarm or a supervisory condition (subject to approval from local code agencies). Smoke and CO alarms shall be MEA approved and installed in accordance with the latest requirements of local code.

I. Duct Detector

Provide Low profile intelligent addressable DUCT smoke detector. Provide for variations in duct air velocity between 100 and 4,000 feet per minute and include a wide sensitivity range of .79 to 2.46%/ft. Obscuration. Include one Form-C shut down relay rated 2.0 amps @ 30 Vdc and also include slave high contact relays if required. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. The addressable DUCT housing shall be suitable for extreme environments, including a temperature range of –20 to 158 degrees F (-29 to 70 degrees Celsius) and offer a harsh environment gasket option. Provide Remote Alarm LED Indicators and/or remote test station as indicated on the project plans.

J. Intelligent Modules—General

It shall be possible to address each Intelligent Signature Series module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:

- Temperature: 32°F to 120°F (0°C to 49°C)
- Humidity: 0-93% RH, non-condensing

K. Single Input Module

Provide intelligent single input modules. The Single Input Module shall provide one (1) supervised Class A input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:

- Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
- Normally-Open Alarm Delayed Latching (Waterflow Switches)
- Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
- Normally-Open Active Latching (Supervisory, Tamper Switches)

L. Dual Input Module

Provide intelligent dual input modules. The Dual Input Module shall provide two (2) supervised Class A input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The dual input module shall support the following circuit types:

- Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
- Normally-Open Alarm Delayed Latching (Waterflow Switches)
- Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
- Normally-Open Active Latching (Supervisory, Tamper Switches)

M. Monitor Module

Provide intelligent monitor modules. The Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The monitor module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

N. Waterflow/Tamper Module

Provide intelligent waterflow/tamper modules. The Waterflow/Tamper Module shall be factory set to support two (2) supervised Class A input circuits. Channel A shall support a Normally-Open Alarm Delayed Latching Waterflow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch. The waterflow/tamper module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

O. Single Input Signal Module:

Provide intelligent single input signal modules. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class A output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The single input signal module shall support the following operations:

- Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
- Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)

P. Control Relay Module:

Provide intelligent control relay modules. The Control Relay Module shall provide one form "R" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The control relay module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

Q. Remote Relays, Multi-Voltage Control Relays

Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be SPDT and rated for 10 amperes at 115 Vac. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac, or 230 Vac. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.

R. Intelligent Manual Pull Stations—General

1. It shall be possible to address each fire alarm pull station without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The manual stations shall have a minimum of 2 diagnostic LEDs mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input circuit wiring shall be supervised for open and ground faults. The fire alarm pull station shall be suitable for operation in the following environment:

   - Temperature: 32^{O}F to 120^{O}F (0^{O}C to 49^{O}C)
   - Humidity: 0-93% RH, non-condensing

2. The manual station shall be painted with a one inch wide (1" W.) white stripe running diagonally from the upper left corner to the lower right corner.

S. Manual Pull Station

Provide intelligent single action, single stage fire alarm stations. The fire alarm station shall be of metal construction with an internal toggle switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" English lettering. The manual station shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

T. Notification Appliances – General

1. All appliances shall be UL Listed for Fire Protective Service.
2. All strobe appliances or combination appliances with strobes shall be capable of providing the "Equivalent Facilitation" which is allowed under the Americans with Disabilities Act accessibly guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed.
3. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel (NO EXCEPTIONS) specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.
4. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from THE CONTROL PANEL MANUFACTURER clearly stating that the control equipment (as submitted) is 100% compatible with the submitted Notification Appliances.

U. Strobes

Provide low profile wall mounted strobes at the locations shown on the drawings. Strobes shall provide synchronized flash outputs. Strobe output shall be field selectable as indicated on the drawings in one of the following intensity levels; 15cd, 30cd, 75cd or 110cd. Low profile strobes shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

V. Temporal Horn Strobes

Provide low profile wall mount horn/strobes at the locations shown on the drawings. The horn/strobe shall provide an audible output of 84.4 dBA at 10 ft at the high setting and for smaller room size locations (as indicated on the plans) a low dB setting (field selectable) of 79.4 dB at 10 ft. when measured in reverberation room per UL-464. Strobes shall provide synchronized flash outputs. The strobe output shall be as indicated on the drawings in one of the following field selectable intensity levels; 15cd, 30cd, 75cd & 110cd devices (the fire alarm vendor may select below 75 candela where allowed by the local authority and/or the latest release of ADA). The horn shall have a selectable steady and/or synchronized temporal output. Low profile horn/strobes shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

W. Temporal Horn

Provide low profile wall mount horn at the locations shown on the drawings. The horn shall provide an audible output of 84.4 dBA at 10 ft at the high setting and for smaller room size locations (as indicated on the plans) a low dB setting (field selectable) of 79.4 dB at 10 ft. when measured in reverberation room per UL-464. The horn shall have a selectable steady or synchronized temporal output. Low profile horn shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

X. Electromagnetic Doorholders – General

Electromagnetic doorholders submitted for use must have written proof of their compatibility for the purposes intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purposes intended.

Y. Electromagnetic Doorholders Wall Mounted, 1504/1505/1508/1509 Series

Provide flush, semi-flush or surface wall mounted electromagnetic doorholder/releases rated at 24 Vac/dc as directed by the Consulting Engineer. Finish shall be brushed zinc.

Z. Operating Instruction/Riser Diagram Holders

Shall be red painted steel, frame holder with clear, Acrylic window with nine inch by twelve inch (9" x 12") dimensions. One (1) holder shall be provided for the fire alarm control panel FACP)/system operating instructions and one (1) holder shall be provided for a reduced copy (8-1/2" X 11") of the fire alarm system riser diagram. The operating instruction and riser diagram holders shall be mounted adjacent to the fire alarm control panel (FACP).

AA. STI Stopper II Lexan Guards

Manual pull stations that are provided with STI Stopper II lexan guards shall include non-audible alarms as required on the plans. They shall be surface or flush mounting, as required for each individual device.

BB. Alarm System Fused Cut-out

The Contractor shall provide an individual cartridge fused cut-out panel with three (3) poles and a removable, solid copper, neutral bar in fuse gap for the FCS and remote transponders.

1. Fused cut-outs shall be provided with silver sand fuses, current limiting type with an interrupting capacity rating of 200,000 amps (r.m.s. symmetrical). The size of the fuses shall be thirty (30) amperes.
2. The fused cut-out panel shall bear an engraved white-core phenolic or bakelite identification nameplate stating in minimum one-quarter inch (1/4") high white letters on a red background "FIRE ALARM FUSED CUT-OUT".
3. A four (4) wire feeder shall bring three phase 120/208 volt service to the fused cut-out. The feeder shall be tapped off the main building service ahead of the main service switch but after the Current Transformers (Metering Transformers).

2.4 SUPPORT FOR INSTALLER AND OWNER MAINTENANCE

A. Provide a coded one-man walk test feature. Allow audible or silent testing. Signal alarms and troubles during test. Allow receipt of alarms and programmed operations for alarms from areas not under test.

B. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.

C. Provide loop controller diagnostics to identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the circuit wiring of remote module shall be identified by device address.

D. Allow the user to display/report the condition of addressable analog detectors. Include device address, device type, percent obscuration, and maintenance indicator. The maintenance indicator shall provide the user with a measure of contamination of a device upon which cleaning decisions can confidently be made.

E. Allow the user to report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity. Include Facility Name, Licensee, Project Program Compilation date, Compiler Version, Project Revision Number, and the time and date of the History Report.

F. Allow the user to disable/enable devices, zones, actions, timers and sequences. Protect the disable function with a password.

G. Allow the user to activate/restore outputs, actions, sequences, and simulate detector smoke levels.

H. Allow the service user to enter time and date, reconfigure an external port for download programming, initiate auto programming and change passwords. Protect these functions with a password.

I. THE END-USER SHALL RETAIN COMPLETE RIGHTS AND OWNERSHIP TO ALL SOFTWARE RUNNING IN THE SYSTEM. The alarm equipment vendor shall provide useable hard and soft copies of the software database to the End-User at the end of the warranty period. The database provided shall be useable by any authorized and certified distributor of the product line, and shall include all applicable passwords necessary for total and unrestricted use and modification of the database. The Consulting Engineer shall define the extent of hardcopy database documentation to be provided.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department and specified within.

B. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.

C. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled so removal of the device is not required to identify the EOL device.

D. All manual pull stations shall be mounted 48 inches above the finished floor, as measured to the handle.

E. All audio/visual devices shall be mounted 80 inches above the finished floor, as measured at the bottom of the lens such that the entire lens is above 80". Devices shall be mounted no less than 6 inches from the ceiling. All audiovisual devices shall have lexan covers in all areas.

F. No area smoke detectors shall be mounted within 36 inches of any HVAC supply, return air register or lighting fixture.

G. No area smoke or heat detector shall be mounted within 12 inches of any wall. All detectors shall be installed in strict accordance with NFPA 72.

H. All mechanical rooms, boiler rooms, wiring closets, custodian rooms, attic spaces, etc. or areas with exposed or hard ceilings shall be piped with 3\4" conduit. Fire alarm cabling may be routed without conduit above hung ceilings. Support with J-hooks every 5 feet. All cabling shall be plenum rated.

I. All areas in public view shall be in metal conduit. All boxes must be painted red and labeled.

J. All addressable modules shall be mounted within 36 inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.

K. New door holders shall derive their 24VAC/VDC power from a separate power supply housed in a dedicated, metal enclosure. The power supply shall be provided with a 120VAC feed, and is to be centrally located to serve door

holders on a per floor or area basis. All existing door holders shall be connected to new FACP. E.C. shall extend all existing wiring in order to make this work. Locations and quantities of door holder power supplies shall be referenced and submitted in the submission package for approval by the Consulting Engineer.

L. All low voltage wiring terminated to the fire alarm system shall be PLENUM RATED with no exceptions and no less than No. 12 AWG in size for NAC circuits and 16 AWG for Initiating Circuits, and solid copper.

M. All line voltage (120VAC) wiring shall be no less than No. 12 AWG in size, and solid copper. This shall include all system grounding.

N. FACP must have a DEDICATED fuse cut-out.

O. All wiring shall be color-coded throughout, to National Electrical Code standards.

P. Power-limited/Non-power-limited NEC wiring standards SHALL BE OBSERVED.

Q. All junction box covers shall be painted red and labeled INTERIOR FIRE ALARM SYSTEM.

R. Alarm system wiring shall not co-mingle with any other system wiring in the facility. Conduits shall not be shared under any circumstance. Only when fire alarm wiring enters the enclosure of a monitored or controlled system will co-habitation be permitted (i.e. at fan starters or elevator controllers). THIS WILL BE FIELD INSPECTED BY THE PROJECT ENGINEER.

S. Fire alarm control panel enclosures shall have engraved labels indicating, “FIRE ALARM SYSTEM”, and the areas of the building served by that panel.

T. Auxiliary relays shall be appropriately labeled to indicate “FIRE ALARM SYSTEM” and their specific function (i.e. FAN S-1 SHUTDOWN).

U. All fire alarm wiring shall be continuous and unspliced. Terminations shall only occur at fire alarm devices or control panel enclosures under terminal screws. All other splicing methods are specifically disallowed (i.e. plastic wirenuts).

V. All alarm wiring shall be installed using a dedicated system of supports (i.e. bridle rings). Fire alarm wiring shall not be bundled or strapped to existing conduit, pipe or wire in the facility. THIS WILL BE FIELD INSPECTED BY THE PROJECT ENGINEER.

W. All alarm wiring shall be sleeved when passing through any wall, using conduit sleeves (1” min.) with bushings, and fire stopped in accordance with Code.

X. The system shall be arranged to receive power from one three wire 120 Vac, 20 A supply. All low voltage operation shall be provided from the fire alarm control panel.

Y. All alarm devices shall be accessible for periodic maintenance. Should a device location indicated on the Contract Drawings not meet this requirement, it shall be the responsibility of the installing contractor to bring it, in writing, to the attention of the Project Engineer. Failure to bring such issues to the attention of the Project Engineer shall be the exclusive liability of the installing Electrical Contractor.

Z. The installing Electrical Contractor shall be responsible for the removal of ENTIRE existing alarm system components and controls on the demolition drawing shown or not, upon approval of the AHJ and the Consulting Engineer. The End-User reserves the right to retain any existing alarm system components, upon their request. All existing alarm system components requiring special handling for disposal (due to radioactivity) shall be the responsibility of the installing contractor. Written proof of proper disposal by the installing contractor shall be required prior to release of outstanding retainage.

3.2 PAINTING

A. Paint exposed electrical, fire alarm conduit and surface metal raceway to match adjacent finishes in exposed areas. Paint conduit and surface metal raceways red in unfinished areas and above finished ceilings.

3.3 FIELD QUALITY CONTROL

A. The system shall be installed and fully tested under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all of the function as specified.

B. The installing contractor or fire alarm equipment vendor shall have no less than two (2) NICET Level II fire alarm technicians dedicated to this project.

C. The Installing Contract and the Alarm System Vendor shall, upon the request of the Consulting Engineer or End-User, attend any and all project meetings for the purpose of accurately determining progress.

D. It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the Consulting Engineer, End-User or AHJ, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.

E. Preliminary Tests

1. Conduct the following tests during installation of wiring and system components. Correct any deficiencies pertaining to these requirements prior to formal functional and operational tests of the system.
2. Ground Resistance
    a. Measure the resistance of each connection to ground. Ground resistance shall not exceed 10 ohms.
3. Dielectric Strength and Insulation Resistance
    a. Test dielectric strength and the insulation resistance of system interconnecting wiring by means of an instrument capable of generating 500 volts dc and equipped to indicate leakage current in 1000 mega-ohms. For the purpose of this test, instrument shall be connected between each conductor on the line and between each conductor and ground at control panel and of line, with the other extremity open circuited and series-connected devices shunted or in place. System shall withstand test without breakdown and indicate a resistance of not less than 500,000 ohms, the measurement being taken after an electrification of not more than 1.0 minute with a dc potential of not less than 100 volts nor more than 550 volts. Dielectric tests shall be witnessed by Engineer or his designee.
4. Smoke and Thermal Sensor Tests
    a. Prior to formal inspection and tests, clean and perform sensitivity tests on each smoke and thermal sensor. Clean the smoke and thermal sensors in accordance with the manufacturer's recommended procedures. Perform voltage activation sensitivity test on each sensor and record the results. Remove sensors with a sensitivity level above or below the UL accepted sensitivity range for that sensor and replace with new sensors. Present recorded data at the formal inspection for verification. Approved copies shall become part of the operations and maintenance manual for the fire alarm system.
5. Field Inspection and Test
    a. Before final acceptance of the work, test each system to demonstrate compliance with the contract requirement. Each system shall be subjected, at minimum, to complete functional and operational tests including tests in place of each smoke sensor and detector, each thermal sensor, each manual station and visual and audio/visual device, tests of wiring supervision and tests of control panel functions. Test the interface to the Public Address system and coordinate the P.A. alarm signal generation with the public address system subcontractor. Preliminary tests shall be performed in accordance with manufacturer's published testing instructions and in accordance with NFPA 72. Furnish one extra Operations and Maintenance Manual with the formal request for final acceptance testing. The system shall be operational, with no trouble or alarm conditions, a minimum of 14 consecutive days prior to formal tests. Printer shall be operational during the preliminary tests and

break-in period. Provide printer records with the request for formal inspection as evidence of completion of required preliminary test.

6. Formal Inspection and Test
   a. The Authority having Jurisdiction will witness formal tests after receipt of written certification that preliminary tests have been completed and that the system is ready for final inspection. The system manufacturer's technical representative shall be present for the inspection and test. At minimum, preliminary tests shall be repeated and functional and operation tests conducted, as requested by the Architect/Engineer. Correct defects and conduct additional tests to demonstrate that the system conforms to contract specifications. Contractor shall provide two-way radios, personnel and test equipment required for conducting tests. Smoke detectors shall be tested using the manufacturer's calibrated test method. In addition, formal testing will require real smoke to be used to test smoke detectors. Canned smoke will not be permitted. Test equipment shall be turned over to the Authority having Jurisdiction following test completion.
7. Manufacturer's Field Service
   a. Manufacturer's Representative

      Furnish the services of a factory-trained fire alarm system manufacturer's representative or technician, experienced in the installation and operation of the type of system being provided, to supervise the installation, testing, including formal testing, adjustment of the system, and instruction to the facility personnel. Furnish names and phone numbers of the factory-trained fire alarm system representatives or technicians.

F. Documentation And Training

1. The contractor shall compile and provide to the owners three (3) complete manual on the completed system to include SITE SPECIFIC operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams and a manufacturer's suggested spare parts list.
2. In addition to the above manuals, the Electrical Contractor shall provide the services of the manufacturer's trained representative for two (2) separate calendar days for a period of four (4) hours per day to instruct the owners' designated personnel on the operation and maintenance of the entire system.
3. As-built drawings shall consist of the following:
   a. Complete revision of all previously submitted drawings
   b. Point-to-point depiction of all device wiring on the device layout floor plans.
   c. One (1) set of B-size, laminated as-built drawings.
   d. Two (2) sets of 30"x42"inch 1\16"=1' scale drawing showing all points of alarm. One set shall be submitted with the close-out documents. Second set shall be mounted in frame with a lexan cover. These drawing must be submitted to project Engineer or approval.
4. Turnover of all software database hard/soft copies shall be required. This shall include all possible programming software logs, diskettes or CDs containing exported project files, hard copies of all device maps, the revision number of the version of programming utility used, and all required passwords. The turnover of all database information shall occur prior to the end of the One (1) warranty period (or period as amended earlier in this specification).

G. Adjustments

1. Equipment manufacturer shall provide necessary subsequent custom reprogramming to modify and adjust operations and individual identification nomenclature to the owner satisfaction four months after final system acceptance and twelve months after system acceptance. Reprogramming is to be done at the job site and witnessed by the Authority having Jurisdiction representative. Revision of as-built and record drawings shall be by the installing Contractor.

END OF SECTION

DIVISION 31
EARTHWORK

SECTION 31 14 13

SOIL STRIPPING AND STOCKPILING

PART 1 — GENERAL

1.1 SUMMARY

A. The Scope of Work in this section includes, but is not limited to the following:

1. Testing of existing site soils.

2. Harvesting and stockpile of existing site soils suitable for Planting Soil.

3. All labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with stripping, testing and stockpiling of existing site soils as specified herein.

4. Clean up and disposal of all excess and surplus material.

B. Related Sections:
1. Section 329100, PLANTING SOIL.

1.2 REFERENCES

A. The following references will be used:
1. ASTM C136, Sieve Analysis of Fine & Coarse Aggregates
2. ASTM D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
3. ASTM D5268, Standard Specification for Topsoil Used for Landscaping Purposes.
4. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.
5. Social Science Society of America (SSSA), Methods of Soil Analysis (www.soils.org)

1.3 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

1.4 DEFINITIONS

A. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.

B. Soil Horizons: as defined in the USDA National Soil Survey Handbook: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242.

C. Subgrade: surface or elevation of subsoil remaining after completing excavation.

D. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

E. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

F. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.5 SUBMITTALS

A. Submit a soil stripping and stockpile plan for approval by the Landscape Architect and Owner's Representative.
   1. Include a map of how the soils vary across the area to be harvested, existing topsoil (O and or A horizon) depths, and planned stripping depths.
   2. Soil sampling sites should be clearly marked on the plan.

B. Submit certified soil test analysis reports for a minimum of 5 samples obtained on site that represent the range of the soil available at the source. Samples should be labeled to include the location of the source of the material. All soil testing will be at the expense of the Contractor.

C. Provide a particle size analysis (% dry weight) and USDA soil texture analysis.

D. Provide the following other soil properties:
   1. pH and buffer pH.
   2. Percent organic content by oven dried weight.
   3. Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
   4. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
   5. Cation Exchange Capacity (CEC).

E. Provide certification that soil to be stockpiled is free of hazardous compounds as described herein.

1.6 QUALITY ASSURANCE

A. Soil testing laboratory qualifications: an independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in USDA agricultural soil testing, Planting Soil Mixes, and the types of tests to be performed. Geotechnical engineering testing labs shall not be used.
   1. Recommended Laboratory: Wallace Laboratories, us.wlabs.com.

1.7 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

PART 2 — PRODUCTS

2.1 NATIVE TOPSOIL

A. Topsoil shall be harvested on site from the O and or A horizons of the soil profile.

B. Soil texture shall be loamy (sandy loam, silt loam, sandy clay loam, clay loam) with average clay content maximum 25% and silt content no more than 30%.

C. Soil shall contain less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substance that is potentially toxic to plant growth. Gravel and stone content shall be less than 15% by weight.

D. Soil must be free of plants or plant parts of bermudagrass, quackgrass, Johnsongrass, nutsedge, poison ivy, thistles, or others as specified.

E. Soil must be free of contamination from hazardous compounds, including metals, polynuclear aromatic hydrocarbons (PAHs), and petroleum compounds in excess of concentrations higher than NYS Department of Environmental Conservation (DEC) Soil Cleanup Objectives limits.

PART 3 — EXECUTION

3.1 COORDINATION

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.2 PREPARATION

A. All Erosion and Sedimentation control measures should be in place prior to soil harvesting.

B. Underground conditions:
1. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
2. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required.

C. Remove existing sod and grass before proceeding.

3.3 HARVESTING

A. Contractor shall strip available Topsoil to its full depth from within the Contract limits, excluding areas in close proximity to trees designated to remain, unless otherwise specified or directed by the Owner's Representative.

B. Soil stripping should not be performed when soil is wet or frozen.

C. Excavate soil using equipment and methods to preserve the clumps and peds in the soil. Generally this means using the largest piece of equipment that is practical for the project size and scope. Do not screen soil.

D. Strip Topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

3.4 STOCKPILING

A. Contractor shall stockpile Native topsoil in a storage pile in an area as directed by the Owner's Representative. Contractor shall not stockpile topsoil within the dripline of trees to remain.

B. Locate stockpiles so that they are 50 feet from any storm drain inlet, open channel, wetland or waterbody. Redirect any concentrated flow around the stockpile using an approved erosion and sediment control measure.

C. Storage pile shall be shaped to freely drain surface water during and after stockpiling operations. Side slopes of the stockpile shall not exceed 2:1. Contractor shall limit height of topsoil stockpiles to 72 inches.

D. Secure the perimeter of the stockpile with an approved erosion and sediment control perimeter device.

E. Protect stockpiles from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage.

F. Protect stock piles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season, location, and length of expected time of storage.
   1. The vegetation chosen shall last the duration of the stockpile; the stockpile shall be restabilized if the temporary vegetation dies or erosion results.
   2. Weeds should not be allowed to grow on stockpiles.

G. Excess topsoil shall be hauled by the Contractor and stockpiled on the Owner's property as directed by the Project Representative.

3.5 PROTECTION

A. Damage done by the Contractor, or any of their sub-contractors to existing or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory. Damage to existing trees shall be assessed by a certified arborist.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 321216

BITUMINOUS CONCRETE PAVING

PART 1 — GENERAL

1.1 SUMMARY

A. This section includes
   1. Pedestrian Bituminous Concrete Pavement for paths

B. Provide all equipment and materials, and do all work necessary to construct the bituminous concrete paving, including new pavement and repairs to existing pavement, as indicated on the Drawings and as specified.

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that relate directly to work of this Section include, but are not limited to:

   1. Section 055901, METAL EDGING.

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

   1. American Association of State Highway and Transportation Officials (AASHTO):
      M 81 Cut-Back Asphalt (Rapid Curing Type)
      M 82 Cut-Back Asphalt (Medium Curing Type)
      M 140 Emulsified Asphalt
      M 226 Viscosity-Graded Asphalt Cement

   2. American Society for Testing and Materials (ASTM):
      D 1557 Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. (4.54-kg) Rammer and 18-in. (475-mm) Drop

   3. Federal Specifications (Fed. Spec.):
      SS-S-1401 Sealing Compound, Hot Applied, for Concrete and Asphalt Pavements

   4. New York State Department of Transportation (NYSDOT):
      Standard Specifications

1.4 QUALITY ASSURANCE

A. Unless otherwise specified, work and materials for construction of the bituminous concrete paving shall conform to the applicable portions of the following:

   1. NYSDOT Specifications Section 302 for base and Section 400 for pavement.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each product used. Provide certifications that materials and systems comply with specified requirements.

B. Installer qualifications: Installer must submit evidence of a successful installation history with comparable materials and designs specified.

PART 2 — PRODUCTS

2.1 ASPHALTIC CONCRETE

A. AASHTO M226 viscosity grade to meet State standard specifications.

1. Binder or bottom course paving for bituminous concrete paths shall have maximum aggregate size passing 1 in. sieve, and bitumen content of 5% ± 1/2% by weight.

2. Top or wearing course paving for bituminous concrete paths shall have maximum aggregate size passing 5/8 in. sieve, and bitumen content of 6-1/2% ± 1/2 % by weight.

2.2 AGGREGATE BASE COURSE

A. Material for aggregate base course shall be a graded, granular, non-frost susceptible, free-draining material, consisting of either durable stone and coarse sand or of blast furnace slag, practically free from loam and clay, and which can be readily compacted to form a stable foundation.

2.3 BITUMINOUS MATERIALS

A. Bituminous materials for prime coat shall be one of the following:

1. Cut-back asphalt (rapid-curing type) conforming to AASHTO M 81, Grade RC-70 or RC-250.

2. Emulsified asphalt rapid-setting type conforming to AASHTO M 140, Grade RS-1.

B. Bituminous material for tack coat shall be emulsified asphalt rapid-setting type conforming to AASHTO M 140, Grade RS-1.

C. Bituminous crack sealer shall be a hot-applied bituminous sealer conforming to Fed. Spec. SS-S-1401

2.4 EDGE RESTRAINT

A. Refer to Section 055901, METAL EDGING.

PART 3 — EXECUTION

3.1 PREPARATION

A. Protection of Existing Conditions:
1. Use every possible precaution to prevent damage to existing conditions to remain such as trees, structures, utilities, irrigation systems, and paving on or adjacent to the site of the Work.
2. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.

3. Provide barricades, fences or other barriers as necessary to protect existing conditions to remain from damage during construction.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of conditions damaged during construction to the construction manager and Owner's Representative immediately.

3.2 GRADING

A. Areas to be paved will be compacted and brought approximately to subgrade elevation under Section 02200, EARTHWORK before work of this section is performed. Final fine grading, filling, and compaction of subgrade to receive paving, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.

B. Existing subgrade material which will not readily compact as required shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to this Section.

C. Subgrade of areas to be paved shall be recompacted as required to bring top 8 in. of material immediately below gravel base course to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D.

D. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing pavement.

E. Materials shall not be stored or stockpiled on subgrade.

F. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall conform to the following:
1. Material shall be legally disposed of off-site.

2. Material shall be disposed of in waste disposal area indicated on the Drawings.

3.3 AGGREGATE BASE COURSE

A. Compaction of aggregate base course shall be to 95% of maximum density as determined by ASTM D 1557, Method D. Stone greater than 2-1/2 in. shall be excluded from course.

B. Width of base course shall be greater than or equal to the width of pavement surface, if continuous lateral support is provided during rolling, and shall extend at least 2 x base thickness beyond edge of the course above, if not so supported.

C. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled outside pavement lines shall be removed and area repaired.

D. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, shall be cleaned, replaced, and otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

3.4 INSTALLATION OF BITUMINOUS CONCRETE PAVING

A. General:

1. Work shall not be performed during rainy weather or when temperature is less than 40^{o} F.

2. Adjacent stone, concrete, or brick work, etc. shall be protected from stain and damage during entire operation. Damaged and stained areas shall be replaced or repaired to equal their original condition.

3. Deliveries shall be timed to permit spreading and rolling all material during daylight hours, unless artificial light, satisfactory to Landscape Architect and Owner's Representative, is provided. Loads which have been wet by rain or otherwise will not be accepted. Hauling over freshly laid or rolled material will not be permitted.

B. Edge restraints:
1. Set and anchor edge restraints per Section 055901, METAL EDGING, and in accordance with manufacturer's instructions.

2. Lay bituminous concrete pavement adjacent to and approximately 1/2 inch over top of edge restraint, depending on expected compaction results.

3. Compact first pass with desired equipment within 6 inches of edge restraint. "Pinch roll" to create a hard joint. Subsequent passes may be directly against or over top of edging to ensure complete compaction of asphalt pavement.

4. Finish pavement shall be compacted and level with, but not to exceed 1/2 inch above top of edge restraint.

C. Placing and Rolling:
1. Asphaltic binder and top courses shall each be applied individually, in single lifts of full thickness indicated on the Drawings.

2. Placing and rolling of mixture shall be as nearly continuous as possible. Rolling shall begin as soon after placing as mixture will bear the operation without undue displacement. Delays in rolling freshly spread mixture will not be permitted.

3. Rolling shall proceed longitudinally, starting at edge of newly placed material and proceeding toward previously rolled areas. Rolling overlap on successive strips shall be greater than or equal to 1/2 width of roller rear wheel. Alternate trips of roller shall be of slightly different lengths.

4. Corrections required in surface shall be made by removing or adding materials before rolling is completed. Skin patching of areas where rolling has been completed will not be permitted. Course shall be subjected to diagonal rolling, crossing lines of the first rolling while mixture is hot and in compactable condition. Displacement of mixture or other fault shall be corrected at once by use of rakes and application of fresh mixture or removal of mixture, as required. Rolling of each course shall be continued until roller marks are eliminated. Roller shall pass over unprotected edge of course only when paving is to be discontinued for sufficient time to permit mixture to become cold.

5. In places not accessible to roller, mixture shall be compacted with hand tampers. Hand tampers shall weigh at least 50 lb. and shall have a tamping face less than or equal to 100 sq. in. Mechanical tampers capable of equal compaction will be acceptable in areas in which they can be employed effectively.

D. Joints:
1. Joints shall present same texture, density, and smoothness as other sections of the course. Continuous bond shall be obtained between portions of existing and new pavements and between successive placements of new pavement. New material at joints shall be thick enough to allow for

compaction when rolling. Compaction of pavement, base, and subgrade at joints shall be such that there is no yielding of new pavement relative to existing pavement when subjected to traffic.

2. Contact surfaces of previously constructed pavement (if greater than or equal to seven days since binder placed), shall be thoroughly cleaned and painted with a thin uniform coating of bitumen immediately before fresh mixture is placed. Tack coat shall be applied at rate which will leave asphaltic residue of 5 to 7 gal./100 sq. yd. after evaporation of vehicle. Base surface shall be dry and clean when tack coat is applied. Asphaltic paving material shall not be placed until vehicle has completely evaporated from tack coat. Adjoining new paving shall be placed before tack coat has dried or dusted over.

E. After final rolling, traffic shall not be permitted on pavement until it has cooled and hardened, and in no case less than six hours.

F. Repairs
1. Portions of pavement courses which become mixed with foreign material or are in any way defective shall be removed, replaced, replaced with fresh mixture, and compacted to density of surrounding areas. Asphaltic material spilled outside lines of finished pavement shall be immediately and completely removed. Such material shall not be employed in the work.

3.5 FIELD QUALITY CONTROL

A. Test pavement continuously following compaction for smoothness and proper profile by laying a 10-foot straightedge on the paving finished surface, applied both parallel to and at right angles to centerline of paved area.
1. Surface shall not vary more than 1/4 inch, except at or grade breaks.

2. At joint with existing pavement, and at other locations where an essentially flush transition is required, pavement elevation tolerance shall not exceed 0.01 ft.

3. At other areas pavement elevation tolerance shall not exceed $\pm$ 0.05 ft.

4. Irregularities exceeding these amounts or which retain water on surface shall be corrected by removing defective work and replacing with new material conforming to this Section.

5. Correct areas not meeting specified surface tolerance immediately after compaction.

B. Verify compliance with ADA ground surface requirements for accessibility.

END OF SECTION 321216

SECTION 32 13 13

LANDSCAPE CONCRETE

PART 1 — GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and Division 1, General Requirements, apply to the work specified in this Section.

1.2 SUMMARY

A. Section Includes:
1. Pedestrian Concrete Pavement
2. Concrete Base Slabs for Concrete Pavers – Vehicular
3. Concrete Footings for Paver Retention Angles.
4. Concrete Sub-stairs and Footings for Monolithic Stone Steps.
5. Concrete Footings for Dry Stacked Stone Wall.
6. Concrete Footings for Granite Curb.
7. Concrete Footings for Monolithic Stone Benches.
8. Concrete Curbs

B. Related Sections:
1. Section 055901, METAL EDGING.
2. Section 079201, EXTERIOR JOINT SEALANTS- SITEWORK.
3. Section 129300, SITE FURNISHINGS.
4. Section 321442, MORTAR SET UNIT PAVING.
5. Section 321640, GRANITE CURBING.

1.3 REFERENCES

A. ASTM - American Society for Testing and Materials:
1. A 36 – Standard Specification for Carbon Structural Steel.
2. A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. A 775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
4. A 884 – Standard Specification for Epoxy-Coated Steel Wire or Welded Wire Reinforcement.
5. C 33 – Standard Specification for Concrete Aggregates.
6. C 39 – Standard Test Method of Compressive Strength of Cylindrical Concrete Specimens.
7. C-94 – Standard Specification for Ready-Mixed Concrete.
8. C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete.
9. C 150 – Standard Specification for Portland Cement.
10. C 171 – Standard Specification for Sheet Materials for Curing Concrete.
11. C 172 – Standard Practice of Sampling Freshly Mixed Concrete.
12. C 260 – Standard Specification for Air-Entraining Admixtures for Concrete.
13. C 309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. C 494 - Standard Specification for Chemical Admixtures for Concrete.
15. C 979 – Standard Specification for Pigments for Integrally Colored Concrete.
16. D 1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
17. D 1751 – Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

18. D 1752 - Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
19. D 3963 - Standard Specification for Fabrication and Job Site Handling of Epoxy-Coated Steel Reinforcing Bars.

B. AWS - American Welding Society:
1. 3.0-41 - Standard Qualification Procedure.
2. D1.4 - Structural Welding Code — Reinforcement.
3. D12.1-61 - Reinforced Concrete Construction.

C. CRSI - Concrete Reinforcing Steel Institute:MSP-1 - Manual of Standard Practice.

D. ACI - American Concrete Institute:
1. 301 - Specification for Structural Concrete for Buildings, Latest Edition.
2. 315 - Details and Detailing of Concrete Reinforcing, Latest Edition.
3. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. 305.1 - Hot Weather Concreting.
5. 306.1 - Cold Weather Concreting.

1.4 DEFINITIONS

A. Approved, Approval, Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing, except where indicated otherwise.

B. Finishing Tolerances:
1. “Class A”: True plane within 1/8-inch in 10 feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.
2. “Class B”: True plane within 1/4-inch in 10 feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.

C. Excessive Compaction: Planting soil mix compaction greater than 80 percent maximum dry density as determined by ASTM D 1557.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples:
1. Expansion Joint Fill Material - Three 12-inch lengths.
2. Micro-Reinforcement – Three-pint freezer bags half full each.
3. Abrasive Grit – Three-pint freezer bags 1/4 full each.
4. Rectangular Dowel Sleeves - Three sleeves.
5. Plate Dowels – Three plate dowels with pocket sleeves.

C. Certificates:
1. Signed certificates from suppliers and manufacturers showing conformance of materials and manufactured items with the standards of this Section.

D. Concrete Mix Design: Mix Design Data for each type of concrete mix including:
1. Name, address, and telephone number of batch plant preparing Statement of Mix Design.
2. Date of Mix Design
3. Project location.
4. Contractor requesting load delivery.
5. Mix Design Number
6. Admixtures.

7. Integral Color Admixtures.
8. Gradations for sand and aggregate.
9. Material weights, specific gravity, and absolute volumes.
10. Basis of testing.
11. Water/cement ratio.
12. Slump.
13. Minimum Compressive Strength.
14. Micro-reinforcement.
15. Waterproofing admixtures.

E. Concrete Mix Revisions: Documentation of revised mix proportions when characteristics of materials, Project conditions, weather, test results or other factors warrant mix adjustments.

F. Test Reports: Compressive strength of concrete test cylinders taken upon delivery of concrete.

G. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer:
1. Installer that has completed in the last two years a minimum three concrete installations similar in material, complexity, and finish quality as indicated for this Project which produced concrete work with a documented record of successful service performance.
2. Employs adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.

B. Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Regulatory Requirements: Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.

D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. General Concrete Mock-up Requirements:
1. Construct as many mock-ups as necessary to achieve an accepted finish over the entire surface of each mock-up.
2. Mock-ups which are completely or partially finished incorrectly will be rejected.
3. Remove rejected mock-ups immediately from the site.
4. The mock-up, when accepted, shall become the Project standard for tolerances and appearance.

F. Pedestrian Concrete Pavement Mock-up: Construct one section of Pedestrian Concrete Pavement, minimum 5’ x 5’ to be reviewed before commencement of further work. Include control joints, at least one expansion joint with fill material and sealant, micro-reinforcement, color admixture, curing compound, and water repellent.
1. Re-work mock-up as required until approved by Landscape Architect.
2. Do not proceed with work until mock-up is approved.
3. Mock-up may be installed and remain as part of the permanent construction assembly if found acceptable by the Landscape Architect.

1.7 DELIVERY, STORAGE AND HANDLING

A. Ready Mixed Concrete:
   1. Ready-mixed concrete shall be mixed and delivered to the point designated as specified in ASTM C94.
   2. Do not add water on the job unless authorized by the Construction Manager. The amount of water, if added, shall be recorded on the delivery ticket. If water is permitted to be added to mixed concrete upon arrival at the job, an additional mixing of 20 revolutions of the drum shall be required.
   3. Furnish duplicate delivery tickets with each load of concrete delivered to the job, one for the Contractor and one for the Owner's Representative. Delivery tickets shall provide the following information:
      a. Date
      b. Name of ready-mix concrete plant
      c. Job location
      d. Contractor
      e. Type and brand name of cement
      f. Class and specified cement contents in bags per cubic yard of concrete
      g. Truck number
      h. Time dispatched and time unloaded
      i. Amount of concrete in load in cubic yards
      j. Admixtures in concrete, if any
      k. Maximum size of aggregate and amount of aggregate of each size per cubic yard
      l. Water added at job, if any

1.8 SITE CONDITIONS

A. Environmental Requirements:
   1. Protect concrete against extreme cold and heat, frost, rapid drying, and damage by rain.
   2. In hot dry weather, erect temporary wind breaks to reduce the wind velocity over the concrete surface.
   3. In hot dry weather, erect temporary sun shades to help control concrete surface temperature.

1.9 WARRANTY

A. General Description: In addition to manufacturer's warranties, warrant Work for a period of one year from the Date of Final (Total) Completion against defects in materials and workmanship.

B. Additional Items Covered: Warranty shall also cover repair of damage to other materials and workmanship resulting from defects in materials and workmanship.

C. Exceptions: Contractor shall not be held responsible for failures due to ordinary wear, neglect by the Owner, vandalism, or other causes beyond the Contractor's control.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

A. Expansion Joint Material:
   1. Williams Products, www.williamsproducts.net.

B. Micro-reinforcement:
   1. Nycon, Inc., www.nycon.com.
   2. The Euclid Chemical Company, www.euclidchemical.com.

C. Integral Color Admixture: Davis Colors, www.daviscolors.com.

D. Dowel Aligners and Rectangular Dowel Sleeves for Square Dowels:
   1. PNA Construction Technologies, Inc., www.pna-inc.com.
   2. Sika Corporation, usa.sika.com.

E. Plate Dowels:
   1. PNA Construction Technologies, Inc., www.pna-inc.com.

2.2 MATERIALS

A. Cement: ASTM C 150, Type II gray Portland Cement.

B. Course Aggregate for Concrete Mix: ASTM C 33.

C. Fine Aggregate for Concrete Mix: ASTM C 33.

D. Micro-reinforcement: ASTM C 1116, 3/4-inch long 100-percent pure virgin nylon fibers. Larger Fibers will not be accepted.

E. Reinforcing Bars: ASTM A 615, grade 60, deformed billet-steel bars, clean and free from rust, scale, or coating that will reduce bond.

F. Tie Wire:16 gauge or heavier, black annealed wire.

G. Supports for Reinforcement:
   1. Meet requirements of CRSI-MSP-1.
   2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic, plastic-protected, or stainless steel.

H. Round Expansion Joint Dowels: ASTM A 615, Grade 60, smooth, billet-steel bars, clean and free of rust and scale.

I. Square Dowels: ASTM A 36, carbon steel square bar, sizes as indicated on the Drawings.

J. Water: Clean, potable, concrete mixing water free from injurious amounts of salts, oils, acids, alkalis, organic materials, iron, rust or other deleterious substances which would cause staining.

K. Air Entrainment: ASTM C 260, non-staining.

L. Expansion Joint Fill Material: ASTM D 1752 Type II cork, or ASTM D 1752 Type I, sponge rubber with 30 to 40 pounds per cubic foot density, 95 percent minimum recovery and compatible with joint sealant to be used.

M. Form Release Agent: Non-staining material.

N. Curing Compound: ASTM C 309, non-staining, all-resin type, clear except white-pigmented at concrete surfaces to be sand-blasted, compatible with color admixture.

O. Round Dowel Caps: plastic Greenstreak Speed Dowel sleeves sized to fit dowel: or accepted substitute.

P. Rectangular Dowel Sleeves for Square Dowels: PNA plastic square dowel clips or Greenstreak plastic Speed Dowel sleeves for square dowels.

Q. Aligners for Round and Square Dowels: PNA Dowel Aligners, or Greenstreak Speed Dowel Bases, size to fit dowels.

R. Integral Color Admixture: ASTM C 979, Davis Mix-In powdered pigment, Premium Color Group, color to be chosen from manufacturer's full range of silver/grey standard colors by the Landscape Architect.

S. Chemical Admixtures: ASTM C 494.For colored concrete mix, consult color admix manufacturer to verify compatibility with color admixture.

T. High Range Water Reducing Admixture: ASTM 494, Type F or G.

U. Fly Ash: ASTM C 618, Class F, limited to 25 percent of cementitious material by weight.

V. Plate Dowels: PNA Diamond Dowel System including steel load plates and plastic pocket former sleeves, plate sizes as indicated on the Drawings.

2.3 MIXES

A. Mix Design:
1. Employ commercial testing laboratory to design each concrete mix taking into account requirements specified for each mix, material characteristics, specified finish, use of concrete, project conditions, weather, method of delivery and conveyance, test results, and other factors that could affect mix design.
2. Concrete mixtures except for lean concrete shall be signed by a testing laboratory approved by the Owner's Representative. Mixes shall be verified by actual tests on cylinders prior to placing concrete, and compression test shall show values at least 25 percent greater than the minimum strength indicated or specified. Mixes shall conform to governing building code requirements and to the most recent ACI Standards' publication and shall be approved by the Owner's Representative. Contractor shall pay the testing laboratory for cost incurred for the mix design.
3. The amount of fine and coarse aggregates shall be proportioned with respect to each other and with respect to the water content, so that the concrete may be placed without segregation, but in no case shall the volume of the fine aggregates be less than 35 percent of the sum of volumes of fine and coarse aggregates before combining shall not exceed 6 ½ cubic feet per each sack of cement.
4. Water, including moisture contained in the aggregate, shall not exceed the amounts specified in Table 502 (a) of the ACI Building code 318.
5. Submit mix design data to Landscape Architect for review and acceptance.

B. Concrete Mix for Pedestrian Paving, Sub-Slabs Under Vehicular Concrete Pavers, and Concrete Curbs:
1. 4,000-psi minimum strength at 28 days, maximum 4-inch slump, maximum 0.45 water-cement ratio, and with micro-reinforcement at concrete paving to receive sand-blast finish.
2. Do not use calcium chloride or other accelerating admixtures containing calcium chloride, fly ash, or any admixtures that will affect color of concrete.
3. Meet color admixture manufacturer's requirements for dosage rate and mixing color admixture.

C. Concrete for Pedestrian Concrete Unit Paver Sub-slabs and Stone Paving Sub-slabs:3,000 psi strength at 28 days, maximum 4-inch slump.

D. Concrete Mix of Retaining Walls, Wall Footings, and Pole Light Foundations: See Structural Drawings for specific mix requirements.

E. Mixing Concrete: Mix concrete in accordance with ASTM C 94.

PART 3 — EXECUTION

3.1 EXAMINATION

A. General: Examine site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.

B. Substrate Verification: Verify that substrate is at correct elevations.

3.2 PREPARATION

A. Protection:
1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the Work.
2. Provide barricades, fences or other barriers to protect existing conditions to remain from damage during construction.
3. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of damaged plants and structures to the Owner.

B. Substrate Preparation: Remove water and other materials which could be absorbed by concrete.

3.3 FORMWORK

A. General:
1. Construct, erect, shore, brace and maintain formwork in accordance with ACI 301.
2. Construct forms accurately to dimensions, plumb and true to line and grade.
3. Use forms that are strong, mortar tight, braced and tied so as to maintain position and shape during placing of reinforcing and concrete.
4. Construct formwork so that straight lines are perfectly tangent to radii, curves are smooth and flowing, and transitions between changes in vertical gardens of curbs, walls and paving are smooth and gradual with not abrupt or sharp changes unless indicated otherwise on the Drawings.
5. Wavy surfaces and bulged walls or slab surfaces resulting from settlement or springing of formwork will be rejected.
6. Carefully verify and check forms for alignment and level as the Work proceeds.
7. Make needed adjustments or add additional bracing prior to pouring concrete.
8. Install formwork so that forms can remain in place a minimum 24 hours after concrete placement.

B. Formwork Material at Exposed Vertical Surfaces: Smooth metal, resin-coated plywood, or high-density overlay plywood that will provide an ultra-smooth surface without visible wood grain marks.

C. Tolerances for Exposed Concrete:
1. Top of form units shall not vary more than 1/8 inch from a 10 feet long straight edge.
2. Vertical faces shall not vary more than 1/8 inch from a 10 feet long straight edge.

D. Joints:
1. Construct forms and assemble them in such a manner so that joints occur at accepted locations.
2. Seal joints to prevent leakage and provide exposed finish surfaces free of joint marks or any indication of where the form joints occurred.

E. Corners:
1. Form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed to face of concrete.
2. Form exposed corners to produce square smooth, solid unbroken lines, unless indicated otherwise.

F. Other Trade Requirements:

1. Construct chases, slots and recesses as required.
2. Locate inserts, anchor plates and other items to be embedded in concrete where required, properly place and securely anchor.

G. Recesses and Openings: Provide as shown on the Drawings.

H. Prior to Pouring Concrete:
1. Thoroughly clean out forms to be used.
2. Thoroughly wet wood forms where form coatings are not used.

I. Removal of Forms:
1. Do not remove supporting forms or shoring until concrete has sufficient strength to carry its own weight and other loads upon it.
2. Remove forms only after concrete has attained at least 50% of its design compressive strength.
3. Leave formwork on each wall pour an equal amount of time before removing so that possibility of color variation is minimized.
4. Submit time the forms will remain on concrete before removing.

J. Re-use of Forms:
1. Do not reuse if there is any evidence of surface wear or tear which would impair quality of exposed finishes.
2. Store formwork and form materials in such a manner as to prevent damage or distortion.
3. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage to concrete finish.

3.4 REINFORCEMENT

A. ACI and AWS Requirements: Meet applicable requirements of ACI 315 and AWS D1.4.

B. Coordination with Other Trades: Coordinate other trades' schedules to avoid disturbing or moving Work already installed by one trade to admit the Work of another.

C. Supports:
1. Accurately and securely fasten or support reinforcements to prevent displacement before or during pouring.
2. Hang footing bars from forms.

D. Reinforcement Splices:
1. Overlap welded wire fabric one mesh minimum.
2. Reinforcing bar splices shall be ACI Class A lap splices, except where indicated.

E. Round and Square Expansion Joint Dowels:
1. Center vertically in slab, unless indicated otherwise.
2. Center longitudinal position of each dowel horizontally on joint, except where indicated otherwise.
3. Install at same spacing as slab bar unless indicated otherwise on Drawings.
4. Install sleeve on one end of each dowel as indicated on the Drawings.
5. Cut holes in expansion joint fill material accurately to fit tightly around dowels so that concrete will not leak into gaps between the dowels and the expansion joint material.
6. Install dowels 90 degrees horizontally and vertically to expansion joint using dowel aligners to help maintain this alignment.
7. Install the dowel aligners in accordance with the manufacturer's current printed instructions.

F. Plate Dowels:
1. Install at positions and spacing indicated on the Drawings in accordance with manufacturer's current printed installation instructions.

2. On curved formwork, caulk small gaps between pocket formers and formwork with sealant to prevent mortar leakage into pocket former.

G. Clearances:
1. Provide 2-inch clearance between bar and concrete top and formed side surfaces, except where indicated otherwise.
2. Provide 3-inch concrete cover between bar and bottom of concrete at un-formed surfaces of footings and foundations, except where indicated otherwise.

3.5 CONCRETE PLACING

A. Inspection Prior to Mix Placement:
1. Verify formwork is secured firmly in position so that is will not be displaced during pour.
2. Verify reinforcement and dowels are properly spaced and positioned to provide cover indicated.

B. Dampening Substrate and Reinforcement: Immediately prior to placing concrete, thoroughly dampen reinforcement and the substrate on which concrete is to be placed.

C. Placement of Mix:
1. Meet applicable requirements of ACI 304R for measuring, mixing, transporting and placing concrete.
2. Do not add water to mix during delivery, at Project site, or during placement.
3. Deposit concrete in a continuous operation between expansion joints, or accepted cold construction joints.

D. Hot Weather Placement: Meet applicable requirements of ACI 305.1.

E. Cold Weather Placement: Meet applicable requirements of ACI 306.1.

F. Paving Pour Sequence and “Checkerboard” Pattern: First place every other paving panel and let harden to provide solid straight hardened concrete surfaces on which to install expansion joint material followed by infilling the remaining panels.

3.6 FINISHES

A. Broom Finish:
1. Prior to brooming, provide a floated finish.
2. While the surface is still plastic, provide a uniform, broom-texture finish by pulling a fiber-bristle broom uniformly over the surface.
3. Provide texture to match the accepted mock-up finish.

B. Floated Finish for Horizontal Surfaces:
1. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further until ready for floating.
2. Begin floating when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation.
3. During or after the first floating, check the planeness of the surface with a ten foot straightedge applied at not less than two different angles.
4. Cut down high spots and fill low spots, and produce a surface with a Class B tolerance throughout.
5. Re-float the slab immediately to a uniform sandy texture.
6. Do not float concrete excessively so that an excessive concentration of cement paste and fines are brought to the surface.
7. Do not use a jitterbug.

3.7 SAW-CUT CONTROL JOINTS

A. Location, Width and Depth: As detailed on the Drawings

B. Saw-Cutting: Cut as soon as concrete is hard enough that cutting operation will not damage the concrete surface and groove edges and before shrinkage cracking occurs.

3.8 TOOLED CONTROL JOINTS

A. Location, Width and Radius: As detailed on the Drawings.

B. Striking: Form in fresh concrete using a jointer to cut the groove so that a smooth uniform impression is obtained.

3.9 EXPANSION JOINT FILL MATERIAL

A. Locations and Widths: Provide joint material as shown on the Drawings, and where concrete paving abuts walls, curbs, or other structures.

B. Installation:
1. Place joint materials with top edges below the paving surface as shown on the Drawings to provide the correct depth for sealant and for backer rod where backer rod is shown to be installed.
2. Secure expansion joint fill to sides of concrete and other surfaces using contact adhesive or other suitable means to prevent displacement during concrete pour.
3. Install fill material plumb and down to surface of base material so that no concrete will leak under fill material.
4. Cut holes in expansion joint fill material accurately to fit tightly around dowels so that concrete will not leak into gaps between the dowels and the expansion joint material.

C. Forming: Form edges of joints in the fresh concrete using an edging tool to provide a smooth uniform impression with the radius indicated on the Drawings.

3.10 TOLERANCES

A. Top of Concrete Paving: Plus or minus 1/8-inch from elevations indicated on the Drawings.

B. Expansion Joint and Control Joint Alignment: Plus or minus 1/16-inch from a straight line.

3.11 CURING

A. Curing Concrete:
1. Apply to exposed surface of concrete as soon as manufacturer recommends with an airless sprayer.
2. Apply to sides of concrete paving upon removal of form boards.
3. Meet requirements of manufacturer’s current printed application instructions.
4. Apply compound to form a continuous, uniform, coherent film that will not check, crack, or peel.
5. Do not apply to concrete that is still bleeding or has a visible water sheen on the surface.
6. Protect paving surfaces from foot traffic with scuff-proof paper.
7. Immediately re-coat damaged areas of curing compound.

3.12 PATCHING

A. Projections: Remove projecting fins, bolts, wire, nails, etc., not necessary for the Work, or cut them back 1 inch from the surface and patch in an inconspicuous manner.

B. Voids:

1. Fill holes with an accepted patching material the same color and texture as the adjoining concrete.
2. Mix and place patching material and finish flush with the adjacent surface.

C. Corrective Patching:
1. Correct defects in concrete Work.
2. Chip voids to a depth of at least 1 inch with the edges perpendicular to the surface and parallel to form markings.
3. Fill voids, surface irregularities, or honey-combing by patching or rubbing.
4. Insure that concrete surfaces so repaired duplicate the color and texture of the un-patched Work.

D. Defective Work: Remove in its entirety and replace defective concrete Work which after corrective patching fails to duplicate the appearance of un-patched Work as determined by the Landscape Architect and fails to meet the requirements of these Specifications.

E. Sack Finish: A sack finish will not be accepted as means to repair or patch concrete work.

3.13 FIELD QUALITY CONTROL

A. Testing Concrete upon Delivery:
1. Provide minimum three 6 inch by 12 inch cylinders for each 20 cubic yards or 5,000 square feet of pour for testing of compressive strength.
2. Test 1 cylinder at 7 days, test second cylinder at 28 days, and test third cylinder only if needed for confirmation of compressive strength.
3. Meet requirements of ASTM C 39 and ASTM C 172.
4. Testing should be provided by a testing lab employed by the Owner.

3.14 CLEANING

A. Concrete Work:
1. Prior to final review, remove stains, dirt and other materials using water and mild detergents.
2. Do not use other methods of cleaning unless accepted by the Landscape Architect.

3.15 PROTECTION

A. Concrete Work: Protect Work against damage and defacement during subsequent construction operations until date of Final (Total) Completion by installing fencing, barriers and protective coverings.

END OF SECTION

SECTION 32 14 40

SAND-SET UNIT PAVING

PART 1 — GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete Pavers - Pedestrian
2. Concrete Pavers - Vehicular

B. Related Sections:
1. Section 055901, METAL EDGING
2. Section 321313 ,LANDSCAPE CONCRETE
3. Section 321442, MORTAR SET UNIT PAVING

REFERENCES

C. ASTM - ASTM International:
1. C33 Concrete Aggregates
2. C39 Concrete Compressive Strength
3. C144 Aggregate for Masonry Mortar
4. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
5. C150 Portland cement
6. C448 Classification for Sizes of Aggregate for Road and Bridge Construction.
7. C642 Water Absorption, Density, Voids in Hardened Conc
8. C666 Rapid Freeze/Thaw Resistance of Conc
9. C979 Pigments for Integrally Colored Concrete
10. C1028 Coefficient of Friction

1.2 DEFINITIONS

A. Approved, Approval, Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing, unless indicated otherwise.

B. Excessive Compaction: Planting area soil or soil mix compaction greater than 80 percent of maximum dry density as determined by ASTM D 1557.

1.3 ACTION SUBMITTALS

A. Product Data:
1. Concrete Paving Units.
2. Polymeric Sand Joint.
3. Sand for Cement-Stabilized Sand Setting Bed Mix.
4. Cement for Cement-Stabilized Sand Setting Bed Mix.
5. Geotextile Fabric for Sand-Stop Strips.
6. Sealer.

B. Samples:
1. Concrete Unit Pavers: Provide two full size samples of each precast paver to show the full range of color and texture of unit for selection and approval. If sealer is to be applied to precast concrete paving slab, apply sealer on one sample.
2. Polymer Joint Sand: One pint size sample in heavy duty plastic freezer bags of each color.

3. Bedding Sand: One pint size sample in heavy duty plastic freezer bags.

C. Shop Drawings: Provide layout drawings showing pattern of pavers for each paved area, indicate pavers requiring cutting, indicate setting bed methods in each area, and indicate drainage. Include details of setting beds. Indicate details at curbs and vertical surfaces as applicable.

D. Warranty: Provide certified copies of manufacturer's product warranties.

1.4 INFORMATIONAL SUBMITTALS

A. Test Reports: Setting bed sand sieve analysis per ASTM C 136, with test date less than 4 weeks old.

B. Manufacturer's Instructions: Polymer Joint Sand Installation.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Successfully Installed sand-set unit paving projects similar to the quality specified and equal to or greater than the paving area indicated for a period of not less than 5 years.
2. Employs adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.

B. Supplier Qualifications: Company specializing in the manufacture of precast concrete paving units with a minimum of 10 continuous years of documented experience.

C. Source: Obtain each type of paver, joint fill and setting bed material from a single source with resources to provide materials and products of consistent quality in physical properties and with a consistent finish appearance for exposed surfaces.

D. Regulatory Requirements: Comply with requirements of state and local building codes and with rules and regulations relating to building accessibility.

E. General Mock-up Requirements:
1. Construct as many mock-ups as necessary to achieve an accepted finish over the entire surface of each mock-up.
2. Mock-ups which are completely or partially finished incorrectly will be rejected.
3. Remove rejected mock-ups immediately from the site.
4. Mock-ups may be installed and remain as part of the permanent installation if acceptable by the Landscape Architect.
5. The mock-up, when accepted, shall become the Project standard for tolerances and appearance.

F. Paving Mock-ups:
1. Construct mock-ups for each type of paving as indicated in the Paving Schedule on the Drawings.
2. Mock-up area to be used to determine joint sizes, lines, laying pattern, color(s) and texture of the job.
3. Include aggregate base, concrete slab where applicable, setting bed, paver edge restraints, and polymeric sand joints.
4. Compact pavers on setting bed in the specified pattern, install polymeric joint sand, and apply sealer.

G. Pre-installation Meeting:

1. Prior to commencement of concrete unit paving mock-up installation, schedule and conduct an on-site meeting with the Landscape Architect, Project Paving Engineer, and the polymer joint sand manufacturer's representative to review the critical aspects of consolidating the cement-stabilized sand setting bed, installing and wetting the joint sand, required tolerances and other requirements of this Section.
2. Require paver and retention angle installers to attend.
3. Document meeting and submit notes for record purposes.

1.6 DELIVERY, STORAGE AND HANDLING

A. Loading and Shipment:
1. Carefully pack the unit pavers for shipment free from stains, saw mud, and other deleterious material.
2. Exercise precautions against damage in transit.

B. Storage:
1. Store unit pavers on non-staining wood skids or pallets at least 4 inches above grade.
2. Place and stack skids and unit pavers to distribute weight evenly and to prevent breakage or cracking of pavers.
3. Store and protect unit pavers from weather and soiling with waterproof non-staining covers or enclosures but allow air to circulate around unit pavers.
4. Store aggregates where size grading and other required characteristics can be maintained.
5. Store cement in a dry location on elevated platforms under cover and protected from moisture.

C. Handling:
1. Handle unit pavers to prevent chipping, breakage, soiling or other damage.
2. Do not use pinch or wrecking bars without protecting edges of unit pavers with wood or other rigid materials.
3. Lift with wide-belt type slings wherever possible.
4. Do not use wire rope or ropes containing tar or other substances which might cause staining.
5. Use wood rollers and provide cushion at end of wood slides.

1.7 SITE CONDITIONS

A. Environmental Requirements: Meet requirements of polymer joint sand manufacturer's installation instructions.

1.8 WARRANTY

A. General Description: Warrant work for a period of one year from date of Final (Total) Completion against defects in materials and workmanship.

B. Additional Items Covered: Warranty shall also cover repair of damage to other materials and workmanship resulting from defects in materials and workmanship.

C. Exceptions: Contractor shall not be held responsible for failures due to ordinary wear, neglect by Owner, vandalism, and other causes outside the Contractor's control.

1.9 MAINTENANCE

A. Extra Pavers:
1. Deliver to the Owner full size extra unit pavers of an amount equal to one percent of the area of each color and standard size unit paver indicated on the Drawings.
2. Deliver extra pavers to a location within the Project site designated by the Owner's Representative.

B. Maintenance Service:
1. At mid-point of warranty period, unless directed to do so at another time by the Owners representative, and within two weeks of end of maintenance period inspect paver joints for voids and contaminated polymer sand.
2. Within one week, or as soon as weather conditions permit perform Work necessary to replace contaminated sand and fill voids with polymer sand in accordance with the polymer sand manufacturer's instructions.
3. Contractor shall not be held responsible for replacing joint material contaminated or displaced by improper pavement cleaning operations performed by the Owner's maintenance personnel or due to vandalism.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

A. Concrete Unit Pavers:
1. Stepstone Inc, www.stepstoneinc.com, 17025 South Main Street Gardena, CA 90248; tel: (310) 327-7474, (800) 572-9029
a. Refer to Drawings Paving Schedule for paver unit size and style.
2. Alternate: Hanover Architectural Products, www.hanoverpavers.com, 5000 Hanover Road, Hanover, PA 17331; tel: (717) 637-0500, or approved equal.
a. A: Prest 24x36x3; Matrix #1875, Heavy Tudor or Ground Tudor Finish
b. B, C: Plankstone 3x9x3; Matrix #1025, Tudor Finish
c. D1: Plankstone 3x9x3; Super Black, Ground Finish or Matrix #1428, Ground Finish
d. D2: Plankstone 3x9x4; Super Black, Ground Finish or Matrix #1428, Ground Finish
e. E: Plankstone 3x9x4; Matrix #1025, Tudor Finish
f. H: Detectable Warning Paver 12x12; Limestone Grey, Tudor Finish

B. Polymer Joint Sand: Alliance Designer Products, www.alliancegator.com.

C. Geotextile Fabric for Sand-Stop Strips: Carthage Mills, carthagemills.com.

2.2 MATERIALS

A. Concrete Unit Pavers shall be precast concrete, consisting of Portland cement, aggregate and color admixtures.
1. Portland Cement: ASTM C 150, Type III, high early strength.
2. Aggregate: ASTM C 33.
3. Color Admixture: ASTM C979, by Davis Colors, or equal, as required to achieve color as selected. Integral color shall be throughout entire product. Finish color shall not be added as a face mix.
4. Compressive strength: Minimum 5,000 psi.
5. Freeze thaw testing per ASTM C67

B. Geotextile Fabric for Sand-Stop Strips: Carthage 30%.

C. Sand for Setting Bed: ASTM C 33, naturally occurring, angular, silica sand.

D. Polymer Joint Sand: Alliance Gator Super Sand Bond, to be selected from the manufacturer's full range of colors.

E. Portland Cement: ASTM C 150, Type II.

F. Water: Clean, potable.

G. Sealer: Water or acrylic based. Exterior durable and UV light stable. For use if concrete pavers are not factory sealed.
1. Test sealer on sample pavers and mockup to confirm finish. Sealer should not significantly alter appearance of concrete pavers.

2.3 PAVER FABRICATION TOLERANCE

A. Maximum Variation from Thickness: 1/8-inch.

B. Maximum Variation from Face Size: 1/16-inch.

C. Maximum Variation from Flat: 1/16-inch.

2.4 MIXES

A. Cement-Stabilized Sand Setting Bed Mix for Vehicular Concrete Pavers (Types D2 and E):
1. Uniformly blend 1-part cement with 8 parts moist sand using a motorized mortar mix, or other acceptable mixing machine.
2. Blending manually or using a rototiller to mix a pile of sand and cement will not be acceptable because these methods will likely not blend the entire pile of materials uniformly and contamination is more likely.
3. Do not blend more than 1-part cement per 8 parts moist sand because this will make the setting bed too rigid and impervious.

2.5 COLORS AND FINISHES

A. Paver colors: Davis Colors (or equal), integral color admixture. Integral color shall be throughout entire product. Finish color shall not be added as a face mix.
1. Refer to Drawings and Paving Schedule for paver colors.

B. Paver finishes:
1. All finishes shall be sandblasted.
g. Refer to Drawings and Paving Schedule for paver finishes.
2. Walking surfaces of precast concrete paving units shall have minimum coefficient of friction of 0.60, wet and dry.

PART 3 — EXECUTION

3.1 EXAMINATION

A. General: Examine site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.

B. Substrate: Certify that sub-grade preparation, compacted density and elevations conform to the specifications. Compaction of the soil sub-grade to at least 98% Standard Proctor Density per ASTM D 698 is recommended. Stabilization of the sub-grade and/or base may be necessary with weak or saturated sub-grade soils. Inspect sub-grade preparation, elevations and conduct density tests for conformance to specifications.

C. Verify that geotextiles, if applicable, have been placed according to specifications.

D. Verify that aggregate base materials, thickness, compaction, surface tolerances, and elevations conform to the specifications.

E. Verify location, type, installation and elevations of edge restraints around perimeter of area to be paved. Perimeter containment must surround the entire paving area.

F. Verify base is dry, uniform, even and ready to support sand, precast concrete paving units, and imposed loads.

G. Notification of Unsuitable Conditions: Before proceeding with Work, notify Owner's Representative and construction manager in writing of unsuitable conditions.

3.2 PREPARATION

A. Protection:
1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the Work.
2. Provide barricades, fences or other barriers as necessary to protect existing conditions to remain from damage during construction.
3. Use every possible precaution to prevent excessive compaction of planting area soil or soil mixes within or adjacent to the areas of Work.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of damaged plants and structures.

B. Surface Preparation: Remove from concrete base surface plaster, cement, gravel and other materials which would conflict with the sand setting bed thickness and compaction.

3.3 PAVER INSTALLATION

A. Sand-Stop Strips:
1. Install continuous geotextile strips over joints and drain holes, as shown on the Drawings.
2. Lap end edges 2 inches minimum.
3. Protect strips from damage and displacement until covered with pavers.
4. At the gaps between the paver retention angle piece ends, install 4-inch by 4-inch pieces of sand-stop strips under the setting bed and against the vertical leg of the vertical legs of the paver retention angles.
5. Center the sand-stop fabric on the angle end gaps and extend upper edge up to top of polymer joint sand.

B. Spreading Setting Bed:
1. Install straight sand for setting bed of Pedestrian Concrete Pavers (Types A, B, C, D1) and install cement-stabilized sand setting bed mix for setting bed of Vehicular Concrete Pavers (Types D2 and E).
2. Making allowances for compaction, screed un-compacted setting bed material to a consistent thickness which will bring the finish surface of the pavers to the elevations and slopes indicated on the Drawings after compaction.
3. Check and verify effect of setting bed material compaction in a sample panel to determine the screeded bed thickness needed to bring the pavers to the elevations and slopes indicated on the Drawings after compaction.
4. Do not use the setting bed material for leveling.
5. Maintain setting bed in a moist and loose condition and protected against pre-compaction both prior to and following screeding.
6. Screed setting bed material slightly ahead of the laying the unit pavers.

7. Do not screed bedding material in advance of the laying-face to an extent to which paving will not be completed that day.
8. Fully protect screeded setting bed fully against pre-compaction, including compaction by rain or dew.

C. Laying Paver Units:
1. Place unit pavers on the un-compacted and screeded bedding material in the running pattern indicated on the Drawings.
2. Place pavers so that joints are aligned and installed in the pattern with joint widths indicated on the Drawings.
3. Use string lines to hold pattern lines and elevations true.
4. Lay rows of full units first.
5. Cut off and fit closure units subsequently.
6. Cut paver units with power diamond blade masonry saw where partial pavers abut straight surfaces.
7. Cut smooth radial paver edges with a diamond-blade masonry saw by kerfing and grinding, or via other accepted method, where pavers abut round elements such as manholes, bollards and columns to achieve smooth curved edges parallel with the abutting surfaces with maximum 1/4-inch wide polymer sand joints.
8. Do not allow other construction traffic on pavement during the paver installation until pavers have been compacted.

D. Compaction of Larger Pavers:
1. Achieve consolidation of the cement-stabilized bedding material and bring paver surfaces to design levels by using beating block and rubber mallet.
2. Continue beating and leveling pavers until lippage is within the specified tolerance and pavers are at proper elevations.
3. Immediately remove and replace pavers which are damaged during installation.

E. Compaction of Smaller Pavers:
1. Achieve consolidation of bedding material and bring surfaces of pavers to design levels and profiles by not less than 3 passes of a plate compactor.
2. Use a high-frequency, low amplitude mechanical flat plate vibrator capable of minimum 4000 pounds of centrifugal compaction force to a minimum 80 hz. Pass vibrator across the short dimension of the paving units.
3. Install a protective cover on the vibrator plate to protect pavers from damage.
4. Proceed with compaction as closely as possible following laying of pavers and prior to acceptance of pedestrian or vehicular traffic.
5. Do not compact within 3 feet of laying face.
6. Continue compaction until lippage between adjoining paving units is within the specified tolerance and the pavers are solidly seated.
7. Leave work to within 3 feet of the laying face fully compacted at the complete of each work day.
8. Immediately remove pavers damaged by compaction operations and replace.

F. Filling Sand Joints:
1. Install polymer joint sand in accordance with the polymer joint sand manufacturer’s current printed installation instructions.
2. Wet polymer joint sand in accordance with the polymer joint sand manufacturer’s current printed installation instructions.
3. Take special care to remove excess polymer sand from paver surfaces prior to wetting polymer sand in joints.

3.4 TOLERANCES

A. Paver Finished Surface: Do not permit finished paving surfaces to vary more than 1/8-inch measured with a 10-foot long metal straightedge, except at grade changes.

B. Thickness of Setting Bed Over Concrete Base Slab (Sub-slab) after Compaction of Pavers: 1-inch average, 3/4-inch minimum, 1-1/4-inch maximum.

C. Lippage Between Adjacent Pavers: 1/16-inch maximum after compaction of pavers.

D. Polymer Sand Joint Width for Pedestrian Pavers: 1/8-inch average, 1/16-inch minimum and 3/16-inch maximum.

E. Polymer Sand Joint width for Vehicular Pavers: 1/16 inch minimum, 1/8 inch maximum.

3.5 CLEANING

A. Paving Units:
1. Prior to Final Inspection, clean exposed surfaces of paving units with clean water and stiff bristle brush. Acid based cleaners will alter finish and color.
2. Remove and replace permanently stained pavers.
3. Add additional polymer sand to joints where cleaning has dislodged sand and re-wet joints.

3.6 SEALING

A. Field-apply sealing to the entire paving area, including joints, after installation and prior to Final Inspection. Follow sealer manufacturer's instructions for application and maintenance of the sealer.

3.7 PROTECTION

A. Damage and Defacement: Protect paving units against damage and defacement during subsequent construction operations until date of Final (Total) Completion by covering paving with 3/4-inch thick exterior plywood or other acceptable material where subject to traffic damage.

B. After installation and before completion, inspect precast concrete paving units for construction damage and obtain new precast concrete paving units if required.

END OF SECTION

SECTION 32 14 42

MORTAR-SET UNIT PAVING

PART 1 — GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete Unit Pavers – Vehicular Mortar Set
2. Linear Stone Paving
3. Stone Treads for Monolithic Stone Steps

B. Related Sections:
1. Section 057300, EXTERIOR METAL RAILING; Handrails to be embedded in Stone Treads
2. Section 079201, EXTERIOR JOINT SEALANTS- SITEWORK
3. Section 321313, LANDSCAPE CONCRETE; Foundations and footings.
4. Section 341440, SAND SET UNIT PAVING

1.2 REFERENCES

A. ASTM - ASTM International:
1. C33 Concrete Aggregates
2. C39 Concrete Compressive Strength
3. C144 Aggregate for Masonry Mortar
4. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
5. C150 Portland cement
6. C448 Classification for Sizes of Aggregate for Road and Bridge Construction.
7. C642 Water Absorption, Density, Voids in Hardened Conc
8. C666 Rapid Freeze/Thaw Resistance of Conc
9. C979 Pigments for Integrally Colored Concrete
10. C1028 Coefficient of Friction

B. ANSI - American National Standards Institute:
1. A118.4 Latex Portland Cement Mortar.

1.3 DEFINITIONS

A. Approval, Approved, Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing, except when indicated otherwise.

B. Excessive Compaction: Planting area soil or soil mix compaction greater than 80 percent of maximum dry density per ASTM D 1557.

1.4 ACTION SUBMITTALS

A. Product Data:
1. Concrete Paver Unit.
2. Granite Sawn Thins at Linear Stone Paving.
3. Mortar Mixes.
4. Joint Grout.

B. Shop Drawings: Cutting and setting drawings of Stone Treads shall be submitted. Drawings shall indicate sizes, dimensions, layout, finishes, arrangement and provisions for jointing, anchoring, cut-out and holes, and other necessary details for reception of the work of other Sections.

C. Samples:
1. Concrete Unit Pavers: Three actual full size pavers representing color range, and finishes of exposed face, sides, and bottoms. Factory sealed or with concrete sealant applied.

2. Granite Sawn Thins at Linear Stone Paving: Four pieces representing color range, shape and size variation, and finishes of exposed face and sides

3. Stone tread sample: provide a 6 in. x 12 in sample that fully demonstrates color, shade, veining, texture, range, and finish.

4. Grout: Three applied grout color samples selected by the Landscape Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Test Data:
1. Stone Properties Test Data for Each Stone Type, including ASTM C 97 absorption, ASTM C 99 modulus of rupture, ASTM C 170 compressible strength, ASTM C 880 flexural strength, and ASTM C 1353 abrasion resistance.
2. Sound Test Documentation.

B. Manufacturer's Instructions:
1. Mortar Installation.
2. Grout Installation.

C. Purchase Documentation.

D. Purchase and Delivery Invoices for Mortar Mixes and Grout.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
1. Employs adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.

B. Regulatory Requirements:
1. Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.

C. Source:
1. Stone shall be supplied by a source approved by the Landscape Architect or Owner's Representative.

2. Provide each type of stone from only one quarry to ensure consistent color range and texture. Do not change source during the course of the work.

D. Stone shall be standard grade, free of cracks, seams, starts, or other defects which may impair its strength, durability or appearance. Exposed surfaces shall be free from spots, spalls, chips, stains, discoloration, or other defects which would affect its appearance.

E. General Mock-up Requirements:
1. Construct as many mock-ups as necessary to achieve an accepted finish over the entire surface of each mock-up.
2. Mock-ups which are completely or partially finished incorrectly will be rejected.
3. Remove rejected mock-ups immediately from the site.
4. The mock-up, when accepted, shall become the Project standard for tolerances and appearance.

F. Concrete Paver Mock-ups:
1. Construct mock-up as indicated in the Paving Schedule on the Drawings
2. Include concrete base slab, mortar setting bed, and mortared joints.
3. Compact pavers on setting bed in the specified pattern,
4. Mock-ups may be installed and remain as part of the permanent installation if found acceptable by the Landscape Architect.

G. Linear Stone Paving Mock-ups:
1. Construct mock-up as indicated in the Paving Schedule on the Drawings
2. Include concrete base slab, mortar setting bed, paver edge restraint, and mortared joints.
3. Mock-up may be installed and remain as part of the permanent installation if found acceptable by the Landscape Architect.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Loading and Shipment:
1. Carefully pack the unit pavers for shipment free from stains, saw mud, and other deleterious material.
2. Exercise precautions against damage in transit.

B. Storage:
1. Store unit pavers on non-staining wood skids or pallets at least 4 inches above grade.
2. Place and stack skids and unit pavers to distribute weight evenly and to prevent breakage or cracking of pavers.
3. Store and protect unit pavers from weather and soiling with waterproof non-staining covers or enclosures but allow air to circulate around unit pavers.
4. Store aggregates where size grading and other required characteristics can be maintained.
5. Store mortar and grout in a dry location.

C. Handling:
1. Handle unit pavers to prevent chipping, breakage, soiling or other damage.
2. Do not use pinch or wrecking bars without protecting edges of unit pavers with wood or other rigid materials.
3. Lift with wide-belt type slings wherever possible.
4. Do not use wire rope or ropes containing tar or other substances which might cause staining.
5. Use wood rollers and provide cushion at end of wood slides.

1.8 SITE CONDITIONS

A. Environmental Requirements:
1. Protect mortar against frost, rapid drying and damage by rain.
2. Maintain substrate materials and surrounding air to a minimum of 50 degrees Fahrenheit prior to, during, and through curing periods and for a minimum period of 7 days after stone installation.
3. Maintain paver backing and pavers below 90 degrees Fahrenheit prior to, during, and through curing periods and for a minimum period of 7 days after stone installation.

4. Heat materials and surrounding air or erect shade structures if required to maintain specified temperatures.
5. Do not apply setting materials to surfaces that contain frost or ice.
6. Protect mortar and grout from direct sunlight, radiant heat, forced ventilation, and drafts until cured to prevent premature evaporation of moisture.

1.9 WARRANTY

A. General Description: Warrant for a period of one year from the date of Final (Total) Completion against defects in materials and workmanship.

B. Additional Items Covered: Warranty shall also cover repair of damage to other materials and workmanship resulting from defects in materials and workmanship.

C. Exceptions: Contractor shall not be held responsible for failures due to ordinary wear, neglect by Owner, vandalism and other causes outside the Contractor's control.

1.10 MAINTENANCE

A. Extra Paving Units:
1. Deliver to the Owner extra paving units with a combined face area equal to one percent of the respective paving areas indicated on the Drawings.
2. Deliver (1) extra stone stair tread units to a location within the Project site designated by the Owner's Representative.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

A. Concrete Unit Pavers:
1. Stepstone Inc, Gardena CA; tel: 1-800-572-9029; www.stepstoneinc.com
   a. Refer to Paving Schedule on the Drawings for paver unit size, color and style.
2. Alternate: Hanover Architectural Products, www.hanoverpavers.com, 5000 Hanover Road, Hanover, PA 17331; tel: (717) 637-0500, or approved equal.
   a. F: Plankstone 3x9x4; Matrix #1025, Tudor Finish

B. Granite Sawn Thins at Linear Stone Paving: Champlain Stone, Ltd, Warrensburg, NY; tel 518-623-2902; info@champlainstone.com.
1. Color: Corinthian Granite
2. Size: ¾ - 1" thin veneer sized per Drawings in random lengths.

C. Bluestone shall be sourced from Johnston & Rhodes Bluestone Co, East Branch, NY; tel 607-363-7595; info@johnstonandrhodes.com or approved equal.
1. Color range: Blue/Blue
2. Dimensions: As shown in drawings
3. Finish: Split face finish on exposed vertical surfaces, flamed finish on exposed tread. All other surfaces to be sawn.

D. Mortar Setting Bed Mix: Custom Building Products, www.custombuildingproducts.com.

2.2 MATERIALS

A. Concrete Unit Pavers shall be precast concrete, consisting of Portland cement, aggregate and color admixtures.
   1. Portland Cement: ASTM C 150, Type III, high early strength.
   2. Aggregate: ASTM C 33.
   3. Color Admixture: By Davis Colors, or equal, as required to achieve color as selected.
   4. Aggregate for exposed aggregate surface: As selected.'

B. Linear Stone Paving units shall be solid granite.

C. Stone Treads shall be Solid Bluestone
   1. Bluestone shall be cut accurately to required shapes and dimensions.

   2. Holes, cut-outs, sinkages and openings in bluestone work for anchors, cramps, dowels, supports, and lifting devices, shall be accurately cut or drilled to required dimensions, as shown on approved shop drawing and as necessary to secure stone in place to insure correct location and accurate fit of all fixtures. Setting beds shall be shaped to fit supports.

D. Expansion Joint Fill Material: ASTM D 1752 Type II cork, or ASTM D 1752 Type I closed-cell neoprene sponge rubber with 30 - 40 pounds per cubic foot density, compatible with joint sealant.

E. Mortar Mix: Spec Mix Polymer Modified Setting Bed Mortar; or accepted equal.

F. Mortar Colorant:
   1. Color to be selected from full range of manufacturer's standard colors by Landscape Architect.

G. Non-shrink grout
   1. Refer to Section 057300; EXTERIOR METAL RAILING.

H. Water: Clean, potable.

I. Sealer: Water or acrylic based. Exterior durable and UV light stable. For use if concrete pavers are not factory sealed.
   1. Test sealer on sample pavers to confirm finish. Sealer should not significantly alter appearance of concrete pavers.

2.3 PAVER FABRICATION TOLERANCE

A. Maximum Variation from Thickness: 1/8-inch.

B. Maximum Variation from Face Size: 1/16-inch.

C. Maximum Variation from Flat: 1/16-inch.

2.4 MIXES

A. Mortar Setting Bed:
   1. Mix powdered mortar bed mix with water.
   2. Mix in accordance with manufacturer's current printed instructions.

B. Slurry Bond Coat:
   1. Mix powdered mortar bed mix with water.
   2. Mixing: Mix in accordance with manufacturer's current printed instructions for slurry bond coat.

C. Joint Grout: Mix grout mix with water in accordance with manufacturer's current printed installation instructions.

PART 3 — EXECUTION

3.1 EXAMINATION

A. General: Examine site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.

B. Concrete Base:
1. Contractor shall examine the concrete substrates to determine its adequacy to Work of this section. Evidence of inadequate condition shall be brought to the immediate attention of the Landscape Architect.

2. Allow new concrete substrates to cure 28 days at 70 degrees Fahrenheit (21 degrees Celsius) prior to installation of setting materials.

3. Start of work of this Section shall constitute acceptance of the concrete foundation.

C. Notification: Before proceeding with Work, notify construction manager and Owner's Representative in writing of unsuitable conditions.

3.2 PREPARATION

A. Protection:
1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the Work.
2. Use every possible precaution to prevent excessive compaction of planting area soil or soil mixes within or adjacent to the areas of Work.
3. Provide barricades, fences or other barriers to protect existing conditions to remain from damage and excessive compaction during construction.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of damaged plants and structures to the Owner's Representative.

B. Surface Preparation:
1. Clean dirt, oil, grease, plaster, sealers, curing compounds, form oil, loose plaster, paint, scale, and other materials from substrate.

3.3 INSTALLATION

A. Manufacturer's Requirements: Meet requirements of the mortar mix manufacturer's installation and curing instructions, except apply slurry bond coat to sub-slab surface and cure thin-set mortar as required by this Section.

B. Mortar Setting Bed:
1. Just prior to installing mortar setting bed to concrete sub-slab dampen slab with water without causing puddling and uniformly coat surface of base slab with slurry bond coat.
2. Do not install mortar bed on puddled water.

3. While slurry bond coat is still wet and sticky place mortar on slurry bond coated substrate and then screed and compact mortar surface to elevation required to bring finished surfaces to elevations indicated on the Drawings.
4. For mortar beds under the stair tread units install lower half of mortar bed on slurry coated concrete sub-slab first and immediately place WWF sheet over it, followed by placing remainder of mortar over the WWF.
5. Maintain WWF in vertical center of mortar bed.
6. No cold joints will be permitted in the mortar setting bed.
7. Cover mortar bed with plastic until mortar bed is fully cured to prevent rapid moisture loss and curling of the mortar bed.
8. Do not install thin-set mortar on mortar setting bed until mortar bed is fully cured and will accept water penetration.

C. Unit Pavers:
1. Cut and fit pavers neatly and precisely to pattern and layout on the approved shop drawings.
2. Just prior to installing pavers apply a skim coat of thin-set mortar over the surface the mortar bed in accordance to the manufacturer's instructions.
3. Just prior to installing each paver on the skim coat evenly trowel a small quantity of thin-set mortar over the entire clean back of the paver before setting.
4. Clean back of each paver before back-buttering.
5. While the thin-set skin coat on the mortar bed is still wet and sticky and the thin-set mortar coating on the back of each paver is wet and sticky set unit pavers in place and beat with a beating block or rubber mallet to ensure 100-percent full bedding with no voids and with a true surface before the thin-set mortar takes initial set.
6. Install unit pavers with finish surfaces as even as possible with 1/8-inch maximum variation measured from a 10-foot long straight edge and a 1/16-inch maximum lippage between stone units.
7. Make joints straight and of uniform width.

D. Stone Tread:
1. Stone units with chips, cracks, stains, or other defects which might be visible in the finished work shall not be used.
2. Before setting, stone shall be clean and free of dirt, and foreign matter on all sides. Stone shall be dry before setting.
3. Stone shall be set true to the required lines and grades. Joints shall be uniform in thickness.
4. Exposed surfaces shall be kept free from mortar at all times. Any mortar smears shall be immediately removed with a clean sponge and clean water before mortar can set.

E. Expansion Joint Fill:
1. Install expansion joint fill material as detailed on the Drawings.
2. Install expansion joint materials where stone abuts restraining surfaces such as perimeter walls, curbs, columns, wall corners, other types of hard paving and at other locations shown on Drawings.
3. Install expansion joint material while mortar is wet, to separate mortar beds thoroughly and continuously.
4. Where expansion joint fill material is indicated without backer rod, install top of joint fill material at elevation to provide sealant depth recommended by sealant manufacturer and the surface profile indicated on the Drawings.
5. Do not cut-in expansion joints after mortar bed dries.
6. Do not install reinforcing mesh through expansion joints.

F. Curing:
1. After installation, prior to grouting, allow thin-set mortar to cure for a minimum of 48 hours by covering joints and stone surfaces with plastic film at a temperature of 70 degrees Fahrenheit.

2. After 48 hours, pull up representative unit pavers to verify thin-set mortar is fully cured and is not damp or soft.
3. Do not installation joints until thin-set mortar is fully cured.
4. Protect open joints from dirt, chemicals and other contamination while thin-set mortar is curing.
5. Allow mortar setting bed and thin-set mortar to cure at least 14 days before allowing heavy traffic on paving and stairs.

3.4 TOLERANCES

A. Mortar Setting Bed Thicknesses: Plus 1/4-inch to minus 1/4-inch thickness indicated on the Drawings.

B. Thin-set Mortar Bed Thickness: 1/8-inch average, plus or minus a 1/16-inch.

C. Maximum Finished Surface Variation from a 10-Foot Straight Edge: 1/8-inch.

D. Maximum Lippage Between Stone Slab Edges: 1/16-inch.

E. 1/4 Inch Wide Expansion Joint and Grout Joint Width Variation: 1/4 inch average. 3/16-inch minimum, 5/16-inch maximum.

F. Vertical Location of WWF in Mortar Setting Bed: Vertical center of mortar bed plus or minus 1/8-inch.

3.5 FIELD QUALITY CONTROL

A. Mortar Bedding Coverage Inspection:
1. During installation check paver back bedding coverage periodically by removing an installed paver and inspecting bedding mortar transfer onto back of paver.
2. If inspected thin-set mortar is skimmed over (not sticky) remove and replace with fresh thin-set mortar coat.

B. Mortar Curing Inspection:
1. Twenty four hours after installation and prior to installing grout pull up representative stone paver units to verify thin-set mortar is fully cured and not soft or damp.
2. Do not install grout until thin-set mortar is fully cured.

3.6 CLEANING

A. Clean exposed surfaces of paving units, stone treads, grout joints, and expansion joint sealant with clean water and stiff bristle brush.
1. Wire brushes, steel wool, and acids or other solutions which may cause discoloration are expressly prohibited.

B. Remove and replace permanently stained paving units.

C. Do not use wire brushes, acid type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials, tools or methods which could damage finish and color of paving units, stone and joint materials.

3.7 SEALING

A. Unit Pavers:

1. Field-apply sealing to unit pavers over the the entire paving area, including joints, after installation and prior to Final Inspection. Follow sealer manufacturer's instructions for application and maintenance of the sealer.

3.8 PROTECTION

A. Damage and Defacement:
   1. Keep traffic off unit paving for at least 72 hours at 70 degrees Fahrenheit after installation.
   2. Extend period of protection at temperatures below 60 degrees Fahrenheit and at relative humidity above 70 percent.
   3. Protect unit pavers and joint materials against damage and defacement during subsequent construction operations until date of Final (Total) Completion.

END OF SECTION

SECTION 32 14 48

CRUSHED STONE SURFACING

PART 1 — GENERAL

1.1 SUMMARY

A. Section includes:
   1. Crushed Stone Maintenance Strip.

1.2 WORK INCLUDED

A. Provide all equipment and materials, and do all work necessary to construct the crushed stone maintenance strip as indicated on the Drawings and as specified.

1.3 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
   1. 055901, METAL EDGING.

1.4 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.
   1. American Society for Testing and Materials (ASTM):

D 1557	Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. (4.54-kg) Rammer and 18-in. (475-mm) Drop
C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.5 SUBMITTALS

A. Product data including aggregate source, aggregate size chart including sieve analysis that complies with ASTM D 448 and ASTM C 136.

B. A 1 lb. sample of crushed stone shall be submitted for the Landscape Architect's approval of material gradation and color. Samples shall be "range samples" provided from the source stone will be supplied from.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain crushed stone material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

1.7 DELIVERY, HANDLING, AND STORAGE

A. Stone shall be carefully packed and banded by the supplier for shipment. Following shipping stone shall be stored covered with non-staining, waterproof membrane and protected from the weather.

PART 2 — PRODUCTS

2.1 CRUSHED STONE

A. Stone shall be an angular, washed, durable, uniformly graded, 1-1.5" diameter. Gradation shall be submitted to the Landscape Architect for review and approval and shall match approved sample.
1. Stone to be granite or basalt, light gray in color.

2.2 NON-WOVEN GEOTEXTILE

A. Geotextile Fabric shall be Carthage 30% by Carthage Mills, carthagemills.com.

2.3 METAL EDGE

A. Refer to Section 055901, METAL EDGING.

PART 3 — EXECUTION

3.1 GRADING

A. Areas to receive crushed stone surfacing will be compacted and brought approximately to subgrade elevation before work of this section is performed. Final fine grading, filling, and compaction of subgrade to receive surfacing, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.

B. Existing subgrade material which will not readily compact shall be removed and replaced with satisfactory materials.

C. Subgrade of areas to be paved shall be compacted to bring top 8 in. of material to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D. Subgrade compaction shall extend for a distance of at least 6". beyond stone surfacing edge.

D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed.

E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped, and recompacted before placing pavement.

3.2 METAL EDGING

A. Flat vertical steel edging shall be installed at locations indicated on the Drawings. Where required, edging shall be cut square and accurately to required length.
1. Refer to Section 055901, METAL EDGING.

3.3 NON-WOVEN GEOTEXTILE

A. Geotextile fabric shall be installed over compacted base course in accordance with manufacturer's printed instructions. Edges of fabric shall overlap a minimum of 12 in.

3.4 STONE SURFACING

A. Stone surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.

B. Contractor shall inspect drainage columns and strips and verify that they are free of debris and are draining as intended before installing crushed stone surfacing.

C. Crushed stone shall be placed evenly over the non-woven geotextile in 2 in. lifts to depth indicated on the Drawings. Level and smooth surface to lines and grades required.

D. Water shall be added to crushed stone surfacing as required to achieve a dense, hard packed surface conforming to the finish grades indicated.

E. Upon completion of stone surfacing, adjacent surfaces shall be left in a clean, unsoiled condition, acceptable to the Owner's Representative.

3.5 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the requirements of Division 01, GENERAL REQUIREMENTS for removal and disposal of construction debris and waste.

END OF SECTION

SECTION 32 16 40

GRANITE CURBING

PART 1 — GENERAL

1.1 SUMMARY

A. The work includes furnishing all labor, materials, equipment, and supervision to construct the granite curbing, including the upright granite curb and the flush granite curb in accordance with the Drawings and Specifications.

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 321313, LANDSCAPE CONCRETE; Concrete footings, bases and foundations.

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

1. American Society for Testing and Materials (ASTM):
   C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   C 615 Structural Granite

2. New York State Department of Transportation (NYSDOT):
   Specifications Standard Specifications for Highway and Bridges

1.4 SUBMITTALS

A. Samples:
   1. New off-site granite curb: Furnish one 1 ft. length of granite curb, showing color, texture and finish.

B. Submit complete shop drawings of granite curb, including sizes and radial segments for Landscape Architect's approval.

1.5 QUALITY ASSURANCE

A. Unless otherwise indicated, granite curb materials and construction shall conform to the applicable portions of the following:

1. NYDOT Section 714-01, "Stone Curb."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Granite curb units shall be delivered to the job adequately protected from damage during transit.

B. Curb shall be protected against staining, chipping, and other damage. Cracked, badly chipped, or stained units will be rejected and shall not be employed in the work.

PART 2 — PRODUCTS

2.1 NEW GRANITE CURB

A. New, off-site granite curb shall be a structural granite conforming to ASTM C 615, Class I Engineering Grade, suitable for curbstone use. Granite curb shall match existing granite curbs used on Campus, or shall be similar to that produced by Swenson Granite Works 10 Main Street, Rt 109, Medway, MA 02053 Ph (508) 533-2882; Fax (508) 533-3441, Granite of America, 15 Branch Pike Smithfield, RI 02917; Tel. 401-232-2040; H.E. Fletcher Company, West Chelmsford, MA 01863, or other approved supplier.

1. Curb shall be light grey, free from seams which impair structural integrity, and with percentage of wear less than 32%, as determined by ASTM C 131.

B. Curb materials shall conform to NYSDOT Specifications Section 714 and shall meet requirements specified in the following subsection:

Item	Section	Type
Stone Curb	714-01	C

C. Provide depth(s) of granite curb as indicated on the Drawings.

D. Provide sawn head joints on both sides for all curb sizes. Provide split face on exposed vertical faces and thermal finish on top.

2.2 SETTING BED MORTAR – THICK SET

A. Setting bed mortar shall be equal to "Laticrete 3701 Fortified Mortar Bed", a polymer fortified blend of carefully selected polymers, portland cement and graded aggregates, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal. Mix with water according to manufacturer's instructions.

2.3 THIN SET BED AND/OR BOND COAT

A. High strength bond coat between concrete base slab and setting bed mortar, and between setting bed mortar and stone, or thin set mortar bed, shall be equal to "Laticrete 254 Platinum", one-step, polymer fortified, thin-set mortar bond coat, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal.

2.4 MORTAR GROUT FOR POINTING

A. Sanded Grout: shall be 1500 Sanded Grout, a premium, factory prepared grout designed to be mixed with water. 1500 Sanded Grout is formulated from a blend of high strength portland cement, graded aggregates, polymers and color-fast pigments and provides a grout joint that is dense, hard and durable, manufactured by Laticrete International, Inc., One LATICRETE Park North, Bethany, CT 06524-3423 USA · 1.800.243.4788 · +1.203.393.0010, or approved equal.

1. For grout joint widths of 1/16" (1.5 mm) up to 3/8" (9 mm).
2. Color shall match color of granite.

2.5 CONCRETE

A. Concrete for continuous haunch shall conform to Section 321313 LANDSCAPE CONCRETE.

2.6 EXPANSION JOINT

A. Expansion joint to occur in place of mortar joints every 80 feet. If curb section is less than 80 feet long, insert one expansion joint within the section. Expansion Joints shall conform to Section 321313 LANDSCAPE CONCRETE.

PART 3 — EXECUTION

3.1 GRADING

A. Areas to receive granite curb will be compacted and brought approximately to subgrade elevation under Section 312000, EARTHWORK before work of this section is performed. Final fine grading, filling, and compaction of subgrade to receive curbing, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.

B. Existing subgrade material which will not readily compact as required shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be Granular Fill material conforming to Section 312000, EARTHWORK.

C. Subgrade of areas to receive curbing shall be recompacted as required to bring top 8 in. of material immediately below gravel base course to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D. Subgrade compaction shall extend for a distance of at least 1 ft. beyond curb edge.

D. Excavation required in subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade or subbase subsequent backfill and compaction shall be performed as directed by the Landscape Architect as specified in Section 312000, EARTHWORK. Completed subgrade after filling such areas shall be uniformly and properly graded.

E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing granite curb.

F. Materials shall not be stored or stockpiled on subgrade.

G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall be legally disposed of off-site.

H. Prepared subgrade will be inspected by the Landscape Architect. Subgrade shall be approved by the Landscape Architect, Client or Owner's Representative before installation of aggregate base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.

3.2 AGGREGATE BASE COURSE

A. Aggregate base course for paving and the spreading, grading, and compaction methods employed shall conform to standard requirements for usual base course of this type for first class road work, and the following:

1. MHD Specifications Section 405, "Gravel Base Course".

B. Compaction of aggregate base course shall be to 95% of maximum density as determined by ASTM D 1557, Method D. Stone greater than 2-1/2 in. shall be excluded from course.

C. Width of base course shall be greater than or equal to the width of curb surface, if continuous lateral support is provided during rolling, and shall extend at least 2 x base thickness beyond edge of the course above, if not so supported.

D. Aggregate material shall be applied in lifts less than or equal to 6 in. thick, compacted measure. Each lift shall be separately compacted to specified density, using a 6 ton steel wheel roller or vibratory roller equivalent to a 6 ton static roller, or an approved equivalent.

1. Material shall be placed adjacent to wall, manhole, catch basin, and other structures only after they have been set to required grade and level.
2. Rolling shall begin at sides and progress to center of crowned areas, and shall begin on low side and progress toward high side of sloped areas. Rolling shall continue until material does not creep or wave ahead of roller wheels.
3. Surface irregularities which exceed 1/2 in. measured by means of a 10 ft. long straightedge shall be replaced and properly compacted.

E. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, shall be cleaned, replaced, and otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

3.3 SETTING CURB

A. Curb shall be set in continuous concrete footing, with trench bottom at minimum 6 in. below bottom of curb. Excavation shall be filled to required level with base course material as specified above.

B. Vertical face of vertical curb shall be plumb, with curb top parallel to adjacent surface.

C. Curb shall be set accurately to line and grade in continuous haunch. Curb units shall be fitted together as closely as possible. Curb shall not be field cut.

D. Joints, between curb units shall be carefully filled with a cement mortar, and neatly pointed on the top and front exposed portions. After pointing, excess mortar shall be cleaned from curb surface.

E. Backfill material on each side of curb shall be as specified for adjacent surface and shall be thoroughly compacted by means of power tampers. Extreme care shall be taken not to destroy alignment. Curb sections disturbed during backfilling or otherwise shall be reset to line and grade, and properly backfilled.

END OF SECTION

SECTION 328400

PLANTING IRRIGATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation an irrigation system shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:

1. Automatic irrigation system with electric control including piping, fittings and accessories.
2. Drip irrigation.
3. Rain Sensor with related wiring.
4. Moisture sensors with related wiring.
5. Booster pump with related electrical wiring and pipe.
6. Hydrometer with related piping and wiring
7. Controller with related wiring and conduit, electrical wiring.
8. Grounding of Irrigation System.
9. Testing and instruction.
10. Excavating and backfilling irrigation system work.
11. Maintenance and warranty

C. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:

1. Division 26, Electrical
2. Division 22, Plumbing
3. Section 32 91 00, Planting Soil.
4. Section 32 92 19, Seeding and Sodding.

1.3 REFERENCES

A. Standards and Codes that apply to the Work of this Section:

1. RE NEC — National Electric Code, current edition.
2. UPC — Uniform Plumbing Code, current edition.
3. ASTM — ASTM International:
   a. B 3 — Specification for Soft or Annealed Copper Wire.

b. D 698 — Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

c. D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

d. D 1784 — Specification for Rigid PVC Compounds and CPVC Compounds.

e. D 1785 — Specification for PVC Plastic Pipe, Schedule 40.

f. D 2287 — Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion

g. Compounds.

h. D 2241 — Specification for PVC Pressure-Rated Pipe (SDR Series).

i. D 2464 — Specification for Threaded PVC Plastic Pipe Fittings, Schedule 80.

j. D 2466 — Specification for PVC Plastic Pipe Fittings, Schedule 40.

k. D 2564 — Specification for Solvent Cements for PVC Plastic Piping Systems.

l. D 2672 —F 690 — Practice for Underground Installation of Thermoplastic Pressure Piping Irrigation Systems.

4. ANSI — American National Standards Institute: NSF 14— Plastics Piping Components and Related Materials.

1.4 PRE-INSTALLATION MEETING

A. Arrange for a pre-installation meeting. Meeting to be held at a time requested by the construction manager to coordinate all trades and requirements of this Section. Representatives from Architect, Landscape Architect, Construction Manager, Irrigation Design Consultant, the Owner and Contractors are to attend.

1.5 DEFINITIONS

A. The following are industry abbreviations for irrigation materials.

1. Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing.
2. Excessive Compaction: Planting area soil or soil mix compaction greater than 75 percent of maximum dry density as determined by ASTM D 1557.
3. PVC: Polyvinyl Chloride.
4. HDPE: High Density Polyethylene.
5. SDR: Standard Dimensional Ratio.
6. AWG: American Wire Gauge.

1.6 SUBMITTALS

A. Refer to and comply with Section 013300, “Submittals Procedures”, for procedure and additional submittal criteria.

B. Product Data: Manufacturer or supplier's descriptive literature including installation instructions, for each specified product.

C. Submit all product warranties to Owner's representative.

D. Credentials: Name and qualifications of the irrigation contractor including at least three (3) comparable projects of similar work and scope that the Contractor has completed within the last three (3) years with job locations, names of owners and architects, their phone numbers, and dates on which the work on each project was started and completed.

E. Certified Irrigation Contractor: Submit proof of current Irrigation Association Certified Irrigation Contractor (CIC) status.

F. Certifications: Written certification from each product manufacturer or supplier stating that their product conforms to the specified requirements and that all products do not contain hazardous materials.

G. Shop Drawings:

1. Shop drawings showing all piping, conduit, and irrigation equipment for point of connection.
2. Show layouts of system(s) relate to and adjusted together with layouts of on-site design conditions and plantings.

H. Samples: When requested by the Owner's Representative submit each irrigation system component and other item(s) related to the work to confirm product characteristics.

I. Operating and Maintenance Manual: Three (3) manuals describing in detail the step-by-step procedures required for system start-up, operation and shut down of the entire irrigation system. Operating manuals shall include the manufacturer's name, model number, parts list and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Index and arrange the manuals in proper order; include copies of all product literature and their warranties.

J. Warranty: On company letterhead submit a written warranty in the following format:

1. Warranty for ** NAME OF PROJECT** irrigation system we hereby guarantee that the irrigation system we have furnished and installed for **NAME OF PROJECT** is free from defects in materials and workmanship, and the work has been completed in accordance with the Contract Drawings and Specifications, ordinary wear and tear and unusual abuse, or neglect expected. We agree to repair or replace any defects in material or workmanship which may develop during the period of one year from date of the rendition of Certificate of Final Completion and to repair or replace any damage resulting from repairing or replacing of such defects at no additional cost.
   Contractor Name
   Signature: Title:
   Date:

K. GPS Construction Record Drawing:

1. GPS As-Built Drawings to consist of the following: Controllers, Sprinklers, Spray heads, Quick coupling valves, Isolation valves, Automatic valve assemblies, mainline pipe routing, lateral pipe routing, splice boxes, grounding locations with OHM readings, communication cable routing, 2-wire path with decoder numbers. All pipe and wire to have size indicated.
2. Submit two (2) CD-ROM disks with digital drawing (.dwg) file(s) and PDF's suitable for reproduction.
3. Submit "Construction Record Drawings" prior to final review and acceptance.
4. Refer to and comply with additional Record Document requirements in Section 017000 "Execution and Closeout Requirements".

L. Controller Drawings:

1. Controller drawings shall be a reproduction of the construction record drawing reduced and printed on 8½" x 11" 24lb bond paper. Drawings shall be legible. If necessary, use multiple sheets of paper and place drawings back to back.
2. Drawings shall show all irrigation zones highlighted in a different color solid hatch pattern with the designated valve schedule.
3. Seal controller drawings in 10 mil plastic laminate. When multiple drawings are required punch a hole in the upper left had corner of the laminate and connect with a key chain loop.
4. Submit two (2) drawings for each controller.

M. Irrigation Schedule:

1. Using data obtained from the water audit the Certified Landscape Irrigation Auditor shall create a typewritten schedule on 8 ½" x 11" white paper listing each valve number, type of sprinkler (rotor, spray, drip), description of that zone, days to water and daily runtimes for each irrigation month. Irrigation run times based on historical evapotranspiration and rainfall data.

2. Example:

Zone	Type	Days	Description	April	May	June	Jul	Aug	Sept	Oct
1	Drip	MWF	Front Bed	15:00	17:00	25:00	25:00	30:00	18:00	8:00
2	Spray	MWF	Rear Lawn	5:00	6:00	8:00	12:00	13:00	9:00	6:00

3. Schedule shall include the following note: Irrigation runtimes are based on Historical data and should be used only as a guide. All irrigation runtimes should be adjusted accordingly based on actual climatic conditions.
4. Seal irrigation schedule in 10 mil plastic laminate.
5. Submit two (2) irrigation schedules for each controller.

1.7 COORDINATION

A. Thoroughly coordinate and schedule the work of this Section with all trades involved to prevent interferences, and to allow adequate time at the proper stage of construction to properly perform all work of this Section.

B. Coordinate location of all piping and sleeves to be installed under walkway and driveway pavements.

1.8 QUALITY ASSURANCE

A. It is the intent of these Specifications and Drawings to provide for a complete installation. Therefore, any items not specifically noted but, reasonably necessary for a complete installation, shall be furnished. The system is to efficiently and uniformly irrigate all areas and perform as required by the Contract Documents. The irrigation system shall be fully automatic with an electric control.

B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

C. Qualifications:

1. Experienced Contractors are required who are thoroughly trained and experienced in the skills required to install irrigation systems. Contractors to have a minimum of five (5) years' experience in the installation of site irrigation and be regularly engaged in and which maintains a regular work force in the installation of site irrigation.
2. A qualified superintendent shall be present during the installation.
3. Irrigation Contractor shall be a current Irrigation Association Certified Irrigation Contractor (CIC).
4. Materials, equipment, and methods of installation will comply with the applicable requirements of the authorities having jurisdiction including the following codes and standards:
    a. City of Poughkeepsie/State of New York Building Codes
    b. National Fire Protection Association, (NFPA): National Electrical Code.
    c. American Society for Testing and Materials, (ASTM).
    d. National Sanitation Foundation, (NSF).
    e. American Society of Agricultural Engineers, (ASAE).

D. Licenses:

1. A licensed Plumber shall make all plumbing connections. A licensed Electrician shall perform connections to 120 VAC power supplies.

1.9 SITE CONDITIONS

A. Locate and identify installed and existing underground and overhead services and utilities within the contract limits. Install adequate means of protection of utilities and services designated to

remain. Repair utilities damaged during work operations of this Section at the Contractor's expense.

B. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the Owner's Representative and applicable utility company immediately to obtain procedural directions.

C. Cooperate with the applicable utility company in maintaining active services in operation.

D. Locate, protect, and maintain bench marks, monuments, control points and project engineering reference points. Re-establish disturbed or destroyed items at Contractor's expense.

E. Protect existing and newly installed trees, plants, lawn areas, and other features designated to remain as part of the landscape work.

F. Examine the areas and conditions under which site work is to be performed. Promptly notify the Owner's Representative of unexpected sub-surface conditions. Do not proceed with the work until unsatisfactory conditions are corrected.

G. Perform work operations and the removal of debris and waste materials to assure minimum interference with walks and other adjacent site features.

H. Protect existing paving and other services or facilities on site from damage caused by work operations of this Section. Repair and restore damaged items to original condition.

I. Obtain governing authorities written permission when required to close or obstruct streets, walks and adjacent facilities. Provide alternate routes around closed or obstructed streets, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.

J. Failure on part of the Landscape Architect to reject work in the course of operations or during inspection of work is to not be interpreted as acceptance of work not in conformance with these specifications. Correct improper work or materials whenever discovered.

1.10 WARRANTY

A. Warranty the entire irrigation system and all related equipment and accessories for a period of one (1) year from the date of rendition of the Certificate of Final Completion against all defects in workmanship and material.

B. The warranty period will commence upon final acceptance by the Owner for a complete system and/or any portion thereof has been put into operation and acceptable to the Owner's Representative.

1.11 MAINTENANCE

A. During the warranty period, maintain the irrigation system to ensure complete operation of the entire irrigation system. Adjust and repair all settled piping, trenches and sprinkler heads. Correct all defective or damaged work as soon as possible.

B. Return to the site during the subsequent fall season(s) (before October 30th) and winterize the entire system. Drain all water from the system via compressed air and demonstrate to the Owner’s personnel the proper procedures for the system winterization.

C. Return to the site during the subsequent spring season(s) (before April 15th) and start-up the system. Demonstrate to the Owner the proper procedures for the system start-up, operation, and maintenance.

D. System maintenance to begin immediately upon Substantial Completion. Provide continuing maintenance of the irrigation system, as necessary, throughout the installation of the irrigation system.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver the irrigation system components in the manufacturer's original undamaged and unopened containers with labels intact and legible.

B. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.

C. Handle materials to prevent damage.

D. Store materials to protect from sunlight, temperature variation and weather.

E. Provide secure, locked storage for valves, sprinkler heads, and similar components that cannot be immediately replaced, to prevent installation delays.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Apollo Ball Valve, Pageland South Carolina

B. Ashcroft Gauges, Stratford, Connecticut

C. Crispin Valves, Berwick, Pennsylvania

D. Creative Sensor Technology, Inc. Rochester, Massachusetts

E. Dura Plastic Products; Beaumont, California

F. Elchen Industries, Inc. (Turf-Tite), Dallas, Texas

G. Goodall Rubber Company, Trenton, New Jersey

H. Harrington Corporation, Lynchburg, Virginia

I. Hunter Industries, San Marcos, California

J. IPEX Inc Beverly, Massachusetts

K. IPS Corporation, Compton, California

L. JM Eagle, Livingston, New Jersey

M. Lasco Industries, Anaheim, California

N. Maclean Highline Access Boxes, Fort Mill, South Carolina

O. Netafim Irrigation Fresno, California

P. Nibco Inc; Elkhart, Indiana

Q. Oldcastle Enclosure Solutions. Auburn, Washington

R. Paige Electric Corp., Union, New Jersey

S. Rainbird, Glendora, California

T. Storm Manufacturing Group, Torrance, California

U. The Toro Company, Riverside, California

V. Watertronics, Hartland Wisconsin

W. Watts Industries, Inc., Andover, Massachusetts

X. 3M Corporation, Electrical Products Division, St. Paul, Minnesota

2.2 MATERIALS

A. All irrigation equipment shall be provided by an authorized distributor.

B. Water Service, Piping and Fittings:

1. See plumbing drawings.

C. Booster Pump System:

1. Booster pump package shall be a prefabricated system, pre-piped, pre-wired and mounted on a steel skid base minimum three inch (3") welded angle iron or channel brackets, hot dipped galvanized, with a minimum 9/16-inch holes at each corner for bolting to concrete with anchors.
2. Field assembled pump systems are not acceptable.
3. Booster pump station shall be a variable speed packaged pump station rated for 60 GPM @ 25 PSIG boost at station discharge; 3600 RPM 480/3/60 FV, horizontal NEMA faced ODP motors, model SCSUL083CDGXLX5XX as manufactured by Munro or approved equal.
4. Pump Station shall be completely skid mounted with locking enclosure with flanged fittings.

D. Controller:

1. The field satellite shall use solid-state control technology and be capable of automatic, semi-automatic and manual operations
2. The field satellite shall be programmable by the on-board keyboard with rotary dial with back-lit LCD.
3. The field satellite shall have built-in diagnostics indicating specific field satellite or field alarms, network settings and testing of field stations
4. The field satellite shall be in a locking stainless steel, powder-coated metal wall mount, stainless steel pedestal or plastic pedestal
5. Access to high voltage and field wire shall be through a front door panel with a keyed lock.

6. The field satellite shall be capable of operating up to 204 stations.
7. The field satellite shall be capable of connecting either a short-range and/or long-range spread spectrum radio for activation of wireless output remote modules.
8. The field satellite shall have a built-in Ethernet port for optional network connectivity.
9. The field satellite shall have a built-in wireless soil moisture sensing port for optional Wireless Soil Moisture Sensing Base Station connection.
10. The field satellite shall have a built-in USB port for field firmware updates and program back-up.
11. The field satellite shall have (2) built-in nine pin serial ports.
12. The field satellite shall have the ability to communicate and control up to a total of 204 field decoders.
13. The field satellite shall operate 24VAC solenoids and be able to activate (8) decoders, and (8) individual valves simultaneously.
14. The field satellite shall have non-volatile memory and self-diagnostics to identify decoder communication and open circuits.
15. The field satellite shall be able to run all decoders on #14 AWG cable up to 5000' in a straight run.
16. The field satellite shall have the ability to read (2) flow inputs connected directly to a data-retrieval terminal connection inside the field satellite cabinet and read, display and record real-time gallons per minute.
17. The field satellite shall have the ability to read an additional (14) flow inputs via optional wireless output remote modules.
18. The field satellite shall have the capability to activate (16) separate master valves via mirrored master valve designation
19. The field satellite shall come standard with a backup battery for real-time clock retention in the event of a power failure. The field satellite shall maintain the time-of-day, day-of-week.
20. The field satellite control module components shall be enclosed in a stainless-steel enclosure.
21. The field satellite shall be Sentinel model SBAWS5U with 5-year warranty as manufactured by The Toro Company.
22. Control system to include hand-held radio remote for on-site access to irrigation program
23. Include at no additional cost to the Owner two (2) instructional meetings with the Owners designated personnel and the Authorized Representative of The Toro Company. These meetings are to occur upon completion of the irrigation system installation.

E. Maintenance Radio:

1. Sentinel hand held remote shall be model SHHR as manufactured by The Toro Company.

F. 2-Wire Path:

1. Communication wire shall be double jacketed #14-2 conductor cable specially designed for use with Toro two-wire control systems, suitable for direct burial. The conductors shall be tin coated, soft drawn, annealed, solid copper conforming to ASTM 33 with 4/64" thick PVC (polyvinyl chloride) insulation, conforming to UL Standard #493 for thermoplastic-insulated style UF (Underground Feeder), rated at 60- degree C. Wire shall be Paige electric model # P7350D or approved equal.
2. Each two-wire path shall have an outer jacket of a different color.

G. Valve Decoders:

1. Line decoder shall be a fully programmable, direct bury decoder that provides an interface between the 2-wire controller and automatic valve. The output of the decoder shall be 24 VAC. Approved valve decoders shall be models SB-DAC-1 and SB-DAC-2 as manufactured by The Toro Company or approved equal.

H. 24V Electrical Equipment:

1. Low voltage (24 VAC) wire-splice kits shall be UL listed Paige DBM or 3M DBR/Y-6 or approved equal.
2. Conduit for Low Voltage Wiring:
   a. Conduit for 2-wire path (low voltage wiring) shall be rigid Schedule 40 non-metallic conduit and fittings conforming to NEMA TC-2, Federal specification WC1O94A and UL 651 specifications. Fittings are manufactured to NEMA TC-3, Federal specification WC1094A and UL514B. Conduit shall be rated for use for underground, encased or exposed applications in accordance with the National Electrical Code (Article 347). Conduit shall be model Plus 40 as manufactured by Carlon or approved equal.
3. Conduit sealant shall be model FST-Mini duct sealant as manufactured by American Polywater Corporation or approved equal.

I. Grounding/Surge Protection:

1. Grounding plates for grounding decoders and 2-Wire circuits shall be 4” x 3’ x 0.0625” (101.6 mm x 2.44 m x 0.9 mm). A 10-foot (3.05 m) continuous length of 10 AWG, green insulated, with extruded yellow stripe, solid bare copper wire is welded to the plate. Grounding plate shall be Paige Electric model #182201IC.
2. Earth grounding wire shall be 6/1 AWG, green insulated, solid bare copper wire. Paige Electric model #150854.
3. All grounding connectors shall be of the Cadweld "One Shot" fuse type – Model GR1161GPLUS (Paige Electric model #1820037P) and Model GT1161GPLUS (Paige Electric model #1820039P). Connections shall be made utilizing the Cadweld Battery Control Unit, Paige Electric model # PLUSCU. Screw type clamps are not acceptable.
4. Earth contact material for each grounding plate shall be two (2) 50lb bags of “PowerSet” for loose soils, Paige Electric model #1820058 or “PowerFill“ for clay soils, Paige Electric model #1820059.
5. Primary 120 VAC power lightning surge arrestor with visible green LED indicator shall be Paige Electric model #250090LED. Furnish and install Paige Electric model #250090BRKT mounting bracket or approved equal
6. Decoder cable fuse device shall be Paige Electric #DCFD.
7. Field Surge Suppression Device shall be model SB-BLA as manufactured by The Toro Company.

J. Sleeves:

1. Sleeves shall be Schedule 40 PVC pipe w/solvent weld coupling as manufactured by Ipex or approved equal.
2. Furnish and install separate sleeve for piping and wire.
3. Furnish and install PVC sleeves two times (2x) the diameter of the pipe or conduit.

K. Pipes and Tubes:

1. All pipe shall be continuously and permanently marked with manufacturer's name or trademark, materials size and schedule or type of pipe, working pressure at 73 degrees F. and National Sanitation Foundation (NSF) approval.
2. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw materials.
3. Pipe homogenous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.
4. Main line pipe shall be PVC (polyvinyl chloride) SDR-21 (200 psi) solvent weld piping. Pipe shall be manufactured from virgin rigid PVC vinyl compounds with a Cell Class of 12454 as identified in ASTM D-1784. PVC SDR-21 pipe shall be Iron Pipe Size (IPS) conforming to ASTM D-1785. Pipe shall be manufactured with solvent weld bell end joints. Pipe shall be as manufactured by Cresline Plastic Pipe, CertainTeed, JM Eagle or approved equal.
5. Lateral piping shall be POLY (polyethylene) PE 3408/3608 SIDR-15 - 100 psi Non-NSF pipe conforming to ASTM-2239. Pipe shall be as manufactured by Oil Creek Plastics, Inc., Centenial Plastics or Charter Plastics or approved equal.

L. Pipe Fittings:

1. Fittings used on mainline pipe and valve assemblies shall be Schedule 80 PVC (polyvinyl chloride) fittings shall conform to ASTM D 2467. PVC (polyvinyl chloride). Schedule 80 threaded fittings shall conform to ASTM D 2464. All PVC (POLYVINYL CHLORIDE) nipples shall be Schedule 80 with molded threads. Close nipples to not be allowed. Fittings and nipples shall be as manufactured by Spears Manufacturing or approved equal.
2. Fittings used with lateral pipes in the landscape areas shall be PVC insert fittings as manufactured by Spears or approved equal. Clamps shall be stainless steel, worm gear hose clamps with stainless steel screws, series 6800 as manufactured by Ideal or stainless steel "ear" type clamps, series 210 as manufactured by Oetiker.

M. Dielectric Fittings:

1. ASTM F 441/F 441M, Schedule 80, CPVC threaded pipe nipples, 4-inch length.

N. Spray Heads:

1. 6" pop-up spray head shall be model MPR40-6-CV as manufactured by Hunter Industries or approved equal.

2. Plastic nozzles shall be MP Rotator series 1000, 2000 and 3000 as manufactured by Hunter Industries or approved equal.

O. Swing Joints:

1. Swing joint used for pop-up spray heads shall be model SJ-512 as manufactured by Hunter Industries or approved equal.
2. Swing joint used for quick coupling valves shall be PVC (polyvinyl chloride) snap-loc with brass MIPT, model G13S-212 as manufactured by Lasco Fittings, Inc. or approved equal.

P. Drip Irrigation Equipment:

1. Dripper Line: Drip irrigation piping (for plant material) shall be Techline Tubing, model TLCV6-12 as manufactured by Netafim Industries or approved equal.
2. Dripper Line: Drip irrigation piping (for trees) shall be Techline Tubing, model TLCV9-12 as manufactured by Netafim Industries or approved equal.
3. Male Adaptor, model TL075MA, as manufactured by Netafim.
4. Combination Tee, model TL075FTEE, s manufactured by Netafim or approved equal.
5. Soil Staple, model TLS6. As manufactured by Netafim or approved equal..
6. One-inch (1") drip control zone kit shall be model, ICZ-101-25 as manufactured by Hunter Industries or approved equal.
7. Line flushing valve shall be Adapter model H3412P 3/4" MPT x 3/4" MGHT, Shut Off Valve model G3434V 3/4" FGHT x 3/4" MGHT and Cap model N 3400P 3/4" FGHT as manufactured by GreenLeaf Inc or approved equal.
8. Tree drip identifier shall be 1/4" Tubing Stake, 1/4" Distribution Tubing, model XQ , 1/4" Self-Piercing Barbed Connector, model SPB and 1 GPH barbed emitter, model XB-10PC as manufactured by Rainbird or approved equal.
9. Insert fittings for use with Techline tubing, as manufactured by Netafim Irrigation or approved equal.
10. Operation/Pressure Indicator stakes shall be model OPERIND, as manufactured by Rainbird Irrigation or approved equal.

Q. Valves:

1. Valves on the pressure side of the automatic valves shall be SCH 80 PVC body manual ball valves gray in color (150 p.s.i. rated) with NPT connections. Size shall be the same as the automatic valve it serves. Valves shall be series #491 ball valve as manufactured by Lasco or approved equal.
2. Bronze gate valves with NPT 2 ½" and smaller shall be model T-113 or T-113K as manufactured by NIBCO or model 102T or 102T-K as manufactured by Apollo or approved equal.
3. Quick-coupling valves shall be one-piece bronze bodies, double slot, 1" IPS with lock top. Supply four (4) keys. Valves shall be model #5RC as manufactured by Rainbird or approved equal. Coupler shall be model #55K-1 as manufactured by Rainbird; supply four (4) couplers. Brass hose swivels shall be 1" X 3/4" model #SH-1 as manufactured by Rainbird: supply four (4) swivels.

4. Automatic valves shall be plastic globe type, normally closed, electric solenoid-actuated and diaphragm-operated with flow stem. Solenoid shall be epoxy impregnated 24 VAC-60 Hz (18 to 30 VAC), 5.8 VA and shall be suitable for direct burial. Valves shall be capable of manual operation by means of an internal bleed. Sizes shall be as noted on the drawings. Valves shall be ICV series as manufactured by Hunter Industries or approved equal.
5. Master valve shall be brass globe type, normally open, electric solenoid-actuated and diaphragm- operated with flow stem. Solenoid shall be epoxy impregnated 24 VAC-60Hz (18 to 30 VAC), 5.8 VA and shall be suitable for direct burial. Valves shall be capable of manual operation by means of an internal bleed. Valve shall be series 3100 as manufactured by Storm Manufacturing Group, or approved equal.
6. Air release valves shall be Combination Air Release Valve, having a 1" NPT inlet and a 1" Air & Vacuum outlet with a 3/32" Pressure Air Release orifice, for operating pressures of 0-150 psi. The valve shall be Cast Iron Body, Stainless Steel Internals, Stainless Steel Float, and Buna-N seating material. The valve to exhaust large quantities of air on system starts up and allows air to re-enter the pipeline when the line is being emptied or drained. The valve to also vent air that accumulates while the system is under pressure. Valves shall be model IC10 as manufactured by Crispin or approved equal.
7. Identification tags shall be manufactured from polyurethane Behr Desopan, incorporating an integral attachment neck and reinforced attachment hole and will be capable of withstanding 180LBS. pull out resistance. The identification tag shall be approximately 2.25” X 2.75” in size. All lettering shall be hot-stamped in black and capable of withstanding outdoor usage. The standard alpha-numeric designations shall incorporate alpha-numeric lettering 1-1/8” in height. The tag color shall be YELLOW. The marking tag will be single sided stamped with the following identification sequence A1, A2, A3 etc. to match the controller number. The marking tag shall be model ID-STD-Y1. The valve identification tags shall be manufactured by T. Christy Enterprises or approved equal.

R. Valve Boxes:

1. Valve boxes for drip irrigation flush valves shall be 6" diameter valve box. Valve boxes shall be model #708 with snap down black cover as manufactured by Oldcastle Enclosure Solutions or approved equal.
2. Valve boxes for quick coupling valves shall be 10" diameter. Valve boxes shall be model #910 with bolt down option black T-cover as manufactured by Oldcastle Enclosure Solutions or approved equal.
3. Valve boxes used with automatic valve assemblies (other than drip irrigation) shall be 12" x 17" x 12" deep valve boxes: black in color. Valve boxes shall be model #1419-12" with black T- cover and L-Bolt down option as manufactured by Oldcastle Enclosure Solutions.
4. Valve boxes used with drip irrigation valve assemblies shall be 15” x 21" x 12" deep valve boxes: Black in color. Valve boxes shall be model #1220-12" with L-Bolt down option BLACK T-cover as manufactured by Oldcastle Enclosure Solutions or approved equal.
5. Valve box extensions, as required, shall be of the same size, color and manufacturer as the box on which it is used.

S. Rain Sensor and Conduit:

1. Rain sensor shall be wired rain sensor, model TRS with conduit mount as manufactured by The Toro Company or approved equal.
2. Allow for the installation of 100' of ½" rigid conduit to install rain sensor.

T. Hydrometer

2" hydrometer shall be model LHM2TG0053-ME (Normally Open Configuration) with 100' of cable, Photo Diode (PDH) Register - high frequency pulse (open collector) for functions such as rate of flow and recording total volume.as manufactured by Netafim or approved equal.

U. Moisture Sensors/Controls:

1. Moisture sensor shall be Turf Guard model TG-S2-R with Toro Pro receiver model TPS-RX and External mount repeater model TG-R-EXT as manufactured by The Toro Company or approved equal.

2.3 ACCESSORY MATERIALS

A. Pressure Gauges:

1. Pressure gauges shall be stainless steel (0-100 PSI) 2 "diameter x 1/4" NPT, model 20-W-1005S-H-02-L- 100# steel as manufactured by Ashcroft or approved equal.

B. Drainage Stone for Valve Boxes:

1. One-half inch (½") to three-quarter (3/4") size, washed, graded crushed stone.

C. Fabric:

1. Soil separation fabric at valve boxes shall be Mirafi 140N, non-woven, spun bound, polyester geotextile fabric or approved equal.

D. Warning Tape:

1. Three-inch (3") 5mil Non-Detectable Blue Marking tape with the words "Caution Buried Irrigation Line Below" as manufactured by T. Christy Enterprises or approved equal.

E. Brick:

1. Common, grade SW, per ASTM C42.

F. Reinforcing Rods:

1. Steel, galvanized. #4 x 30"

G. Bedding for Piping Material:

1. Coarse, mason sand conforming to ASTM C-33.

H. Trench Backfill in Lawn and Planting Areas:

1. Conform to requirements of soil mixtures as specified in Section 329100.

I. Suitable excavated materials removed to accommodate the irrigation system work are shall be used as fill materials provided it conforms to the requirements of fill as noted above.

1. Soils on site are to consist of sub grade materials and planting soil mix. Materials placed at different levels and thicknesses depending upon planting types and locations. Separation of materials shall be maintained.

J. PVC Cement:

1. PVC (polyvinyl chloride) cement shall be Low-VOC.
2. PVC cement for Schedule 40 PVC shall be Weld-on #721 or Weld-On #725 Wet “R” Dry as manufactured by IPS Corporation.
3. PVC cement for Schedule 80 pipes and nipples shall be Weld-on #711 as manufactured by IPS Corporation.
4. PVC primer shall be Weld-on #P-70 (purple).

K. ADDITIONAL EQUIPMENT:

1. The following materials shall be left with the Owner prior to completion of the work shall be utilized in repair and maintenance.
   a. 60' - 2" PVC pipe - 200 psi solvent weld.
   b. 20' – 1 1/2" PVC pipe - 200 psi solvent weld.
   c. 500’ – 1” poly pipe
   d. 20 – 1” insert tees
   e. 20 - 1” insert elbows
   f. 20 – 1” insert tees (IxIxFNPT)
   g. 25 – 1” couplings
   h. 500’ – 1 1/4” poly pipe
   i. 20 – 1 1/4” insert tees
   j. 20 – 1 1/4” insert elbows
   k. 20 – 1 1/4” insert tees (IxIxFNPT)
   l. 20 – 1 1/4” x 1” reducer (IxI)
   m. 300’ 1 1/2” poly pipe
   n. 20 – 1 1/2” insert tees
   o. 20 – 1 1/2” insert elbows
   p. 20 – 1 1/2” insert tees (IxIxFNPT)
   q. 20 – 1 1/2” x 1 1/4” reducer
   r. 20 – 1 1/2” x 1” reducer
   s. 1000’ - TLCV6-12 Brown (.6gph @ 12” spacing) drip line
   t. 50 – Drip insert couplings
   u. 20 – Drip 1/2” male adapters
   v. 50 – Drip insert elbows
   w. 50 – Drip insert tees
   x. 50 – Drip shut-off valves

y. 500 – 6" soil staple
z. 18 – 4" pop-up rotors spray heads
aa. 6 - 1" valve assemblies (ball valve, automatic valve, valve box, fittings etc.)
bb. 6 - 1" drip irrigation valve assemblies (ball valve, automatic valve, filter, regulator, valve box, fittings etc.)
cc. 6 - 6" valve box with black cover
dd. 6 - Standard valve box with black "T" cover

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions where irrigation is to be installed. Notify the Owner's Representative, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner's Representative.

3.2 PREPARATION AND LAYOUT

A. The location of sprinkler heads, valves and piping, noted on the Contract Drawings, are generally diagrammatic to the extent that swing joints, off sets and all pipe fittings are not shown; exact locations of piping, sprinkler heads, valves, and other components shall be approved by the Owner's Representative in the field prior to the time of installation.

B. Pipe routing is shall be in accordance with the Contract Drawings, however, the Owner's Representative to have the right to change the route and/or depth of the pipe from that shown in cases where rock or other obstacles may interfere with the intended path or depth of the piping.

C. Stake all pipe and wire routes, sprinkler, valve and controller locations in accordance with the locations noted on the Contract Drawings; furnish and install staking prior to the commencement of Work in any area of installation.

D. Notify the Owner Representative a minimum of five (5) days prior to the scheduled staking.

E. Coordinate the irrigation work with planting and lawn work, to have irrigation available at time of the turf and plant material establishment.

F. Coordinate irrigation work with plumbing, electrical and sleeve work.

G. Final system layout shall be acceptable to the Owner's Representative.

3.3 CUTTING AND PATCHING

A. Methods and materials used for cutting and patching shall be acceptable to the Architect.

B. Cut through concrete and masonry with core drills. Jack hammers not permitted.

C. Seal all openings in exterior walls water tight with link seals.

3.4 CONDUIT:

A. Install all electrical conduits for 24V control wiring.

B. Backfill and thoroughly compact around all conduit.

C. All conduits to have a minimum cover of eighteen inches (18").

3.5 SLEEVES:

A. Coordinate and install sleeves for all piping and conduit/24V control wire passing through concrete curbing, concrete or masonry walls and floors while the same are under construction.

B. Install ends of sleeves six to twelve-inches (6”-12") beyond the edge of all pavement and curbs.

C. Backfill and thoroughly compact around all sleeves.

D. All sleeve locations shall be staked or permanently marked.

3.6 INSTALLATION

A. Plumbing:

1. See plumbing drawings for point(s) of connection.

B. Winterization Assembly:

1. Install winterization assemblies as detailed on the Contract Drawings.

C. Main Line Isolation Valve(s):

1. Install main line Isolation valves as detailed on the Contract Drawings.

D. Booster Pump Package:

1. The Irrigation Contractor shall be responsible for providing all materials, equipment and labor necessary to install all items associated with the packaged pump station.
2. Setting of the pump station shall be supervised by the pump station manufacturer's representative. The crane shall be supplied by the contractor.
3. When discharge piping, electrical connections and electrical inspection have been completed and the irrigation system can deliver 100% of the total system demand, the pump station manufacturer shall be contacted for startup. A minimum one-week notice shall be given to the manufacturer prior to start-up date. During start up the complete pumping system shall be given a running test of normal start and stop and fully loaded operating conditions. During this test, the pump to demonstrate its ability to operate without undue vibration or overheating and to demonstrate without question its general fitness for service. All defects shall be corrected, and adjustments made.
4. After the startup has been completed, but before leaving the job site, a training session will be given.
5. The training session will be given to the Owner and the Owner's representative to familiarize them with the pumping system operation, maintenance and adjustments.

E. Booster Pump Power Supply:

1. Booster pump power supply shall be supplied from a dedicated circuit and brought to the booster pump location (installed as work of other section(s) and separate contract).
2. The Contractor shall be responsible for all wiring and associated equipment to connect power supply to the booster pump.
3. All wiring is shall be in accordance with all state and local codes.

F. Master Valve:

1. Install master valve on mainline and connect to the master valve terminal of the irrigation controller. See detail drawings.

G. Excavating and Backfilling:

1. Provide all excavation, backfilling and compaction required for the proper installation of all piping.
2. All main line piping is shall be trenched by hand or machine. Pipe pulling method is not shall be used.
3. Minimum trench width shall be three inches (3") on each side of the main line pipe and one and one-half inches (1½") on each side of lateral pipe to allow for proper compaction of backfill material.
4. Prior to excavation of trenches carefully lift existing sod at the location of all piping, connections, sprinklers, quick couplers and valve boxes. After components are installed, cut the sod to fit and replace it.
5. Excavate to the depths required to allow a four-inch (4") depth of sand bedding material for piping when unsuitable bearing materials are encountered.
6. Minimum depth of cover:
   a. Main line piping: - eighteen inches (18") of cover.
   b. Lateral piping: - fourteen inches (12") of cover.
   c. Control wire: - eighteen inches (18") of cover.
7. The trench bottom should be smooth and free of rocks greater than one and one-half inches (1 1/2") diameter, large dirt clods or any frozen material. Excavation at bells (bell holes) should be provided to allow pipe shall be fully supported along its length.
8. Bed pipe to provide uniform longitudinal support under the pipe to prevent low spots.
9. Backfill material shall be free from rock, large stones, or other unsuitable substances to prevent damage to pipe during backfilling operations. Refer to section 312000 "Earthmoving".
10. Install a four-inch (4") depth of sand bedding material where pipe settles on rock, shale or where the pipe cannot be fully supported along its entire length.
11. Initial four inches (4") of backfill shall be properly compacted continuously above the bedding and around the pipe as well as between the pipe and undisturbed trench walls. Initial backfill is shall be done by hand.
12. Backfill trenches to match adjacent grade elevations with approved trench backfill material. Place and compact fill in layers not greater than six-inch (6") depth to ninety-five percent (95%) maximum dry density at optimum moisture content under all paving areas and eighty five percent (85%) maximum under lawn and planting areas.

13. Install warning tape directly above pressure piping, 12 inches (12") below finished grades, except 6 inches (6") below subgrade under pavement and slabs.
14. Throughout the duration of the Contract refill any trenches that may have settled.
15. Excavate trenches; install piping and backfill during the same working day. Do not leave open trenches or partially filled trenches overnight.

H. Pipe Laying:

1. Inspect the pipe for defects before installation. Defective, damaged or unsound pipe will be rejected.
2. Install PVC piping in dry weather when temperature is above 40 degrees Fahrenheit. Allow joints to cure at least twenty-four (24) hours at temperatures above 40 dig F before testing.
3. Make solvent weld joints in strict accordance with ASTM D2855 and the manufacturers printed instructions. Color primer shall be used.
4. Allow joints to set at least twenty-four (24) hours before pressure is applied to the system.
5. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress.
6. Install all wall penetrations through planter walls where required to make plumbing and/or electrical wiring connections. All penetrations shall be watertight.
7. Insert type fittings on laterals one and one quarter inches (1¼") and larger shall be double clamped.

I. Clearances:

1. Minimum horizontal clearances between pipes: four-inches (4") for two-inch (2") pipe and less; twelve-inches (12") for two-inch (2") pipe and more.
2. Minimum vertical clearances between pipes: Two-inches (2").

J. Dielectric Fittings:

1. Where pipes of dissimilar metal are joined, make connection with dielectric fitting.
2. Provide dielectric fittings between copper and ferrous metal piping and materials in accordance with Section 220500.

K. Sprinklers, Spray Heads, Quick Coupling Valves, Fittings, and Accessories:

1. Sprinklers and Quick Coupling Valves shall be connected to the piping system by installing factory assembled PVC swing joints. Swing joint size shall be the same size as that of the IPS inlet of the sprinkler, or as otherwise shown. The long nipple of the swing joint shall be set between 20 and 60 degrees from the horizontal. Install quick coupling valve in six-inch (6") valve box and set within one inch (1") of the bottom of the box cover. See detail drawings.
2. All sprinklers and quick-coupling valves shall be set flush to grade.
3. Install fittings, valves, sprinkler heads, risers and accessories in accordance with manufacturer's printed instructions, except as otherwise indicted or as detailed on the Contract Drawings.
4. Install all pop-up spray heads with flex pipe swing joints as shown on the drawings.

L. Valve Boxes and Valve Assemblies:

1. All valve box locations shall be staked prior to installation and approved by the Landscape Architect prior to starting construction.
2. Valve boxes shall be installed as shown in the Contract Drawings with adequate space for operation, service and removal of the equipment in the box.
3. A minimum of six-inches (6") of one half-inch (½") gravel shall be placed under, in and around each valve box for both drainage and leveling the box. Gravel installed inside valve box is not acceptable.
4. Where necessary to properly fit the pipe, boxes shall be neatly cut to provide a firm fit to the pipe. Do not allow soil or gravel to enter the box through these cut-outs.
5. Install filter fabric under gravel and around valve box as detailed on the Contract Drawings. Duct tape fabric to valve box.
6. Do not group more than two (2) irrigation valve boxes together in one location. When grouping two valve boxes together allow twelve-inches (12") of space between boxes.
7. All boxes shall be mounted plumb and flush to grade - extensions shall be used as required for proper installation and setting. Surrounding grade shall be established with the use of a leveling board not less than four feet (4') in length. Box shall be set to the underside of this board.
8. Do not install more than two (2) valve assemblies per valve access box.
9. Install all valve boxes in planters in a location approved by the Owner's representative.
10. Seal threaded connections on pressure side of control valves with Teflon tape.
11. Automatic valve assemblies shall be as per Contract Drawings using standard brass nipples, Heavy Duty brass fittings and PVC Schedule 80 nipples.
12. Ball valves shall be installed in the "closed" position and to not be opened until the main line piping system has been pressurized and flushing has been completed through the blow-out valve assembles.
13. Assemble threaded PVC to PVC, or brass to PVC, with the use of two (2) wraps of Teflon tape.
14. Assemble threaded connections so that thread sealant or Teflon tape does not enter the pipe or fitting.
15. Automatic valve manual bleeds to not be used for continual operation. For extended use without 24VAC, the manual bleed shall be left in the open position and the flow to the zone controlled (on-off) by the manual ball valve.
16. Install valve identification tag on each valve assembly as shown on the drawings.

M. Drip Irrigation:

1. Install drip irrigation as detailed on the Contract Drawings. Do not install dripper line in a serpentine fashion.
2. Install dripper line two-inches (2") below finish grade (not below mulch) in shrub beds.
3. Install low flow pressure regulator on irrigation zones under 5 gpm.
4. Install high flow pressure regulator on irrigation zones over 5 gpm.
5. Connect dripper line to header and exhaust manifold as detailed.
6. Install flush valve on exhaust manifold as detailed.

7. Staples shall be spaced a maximum of five feet (5') and at every fitting to hold the dripper line in place.
8. Install indicator stake at all drip irrigation zones in a location approved by the Architect.
9. All drip irrigation zones shall be tested, in the presence of the Landscape Architect, for proper coverage prior to installing mulch. Provide three (3) days' notice prior to testing.

N. Controller:

1. Controller shall be wall mounted in the mechanical room in a location approved by the Architect. Install the controller in accordance with manufacturer's printed instructions and connected to form an operational system. Diagrammatic location shown on the drawings.
2. Controller shall be connected to its individual ground to obtain 15 OHM readings, or less.
3. Install controller in accordance with all state and local codes.

O. Controller Power Supply:

1. Power to the controller shall be supplied from a dedicated circuit and brought to the controller location (Installed as part of work of other section(s) and contract).
2. Controller to have one circuit with full time 120 VAC GFCI outlet and 120 VAC to the controller with on/off switch.
3. Install lightning surge arrestor with mounting bracket on the 120 VAC power supply to the controller.
4. The irrigation Contractor shall be responsible for all wiring and associated equipment to connect power supply from dedicated circuit to the controller.
5. The controller shall be grounded to the building ground by connecting the ground lug of the controller directly to the building ground using a bare #6 AWG wire as per the National Electric Code (NEC). Refer to section Grounding/Surge Protection:
6. The controller shall be grounded to the building ground by connecting the ground lug of the controller directly to the building ground using a bare #6 AWG wire as per the National Electric Code (NEC).
7. All wiring is shall be done by a licensed professional in accordance with all State and local codes. Refer to and comply with Electrical work requirements specified in Division 26.

P. 2-Wire Path:

1. Install two-wire path(s) in conduit without any damage including nicks, cuts or abrasions to the outer jacket. Conduit should be laid in the same trench adjacent to the irrigation mainline. Install wire with slack to allow of thermal expansion and contraction.
2. Seal all wire conduits with duct sealant.
3. Install two-wire path with a thirty-six (36") slack loop at each remote-control valve box to allow raising the valve bonnet to the surface without disconnecting the wires when repair is required.
4. Install an expansion curl on each wire conductor at all wire connections of all valves and splices. Expansion curls shall be formed by wrapping each wire conductor six (6) turns of wire around a one-inch (1") diameter pipe, then withdrawing pipe.
5. Connect each remote-control value to decoder and connect to two-wire path. All connections to be done using a waterproof connector.

6. Make all wire splices by baring a three-quarters inch (3/4") of copper conductor, twisting the leads together. Wire nuts are shall be used over the connection. Make wire splice completely waterproof using approved connector kits in strict accordance with the manufacturer's printed instructions and local codes.

Q. Sleeves

1. Sleeves to extend two (2) feet beyond pavement, road or culvert and shall be plugged with duct seal.

R. Waterproof Connectors:

1. All connectors shall be installed per manufacturer's written specifications.
2. Verify that no loose, unshielded wiring shall touch the ground, water, or other copper conductor causing a leakage of current to the ground or a short circuit across wires.
3. Score the outer jacket of the wire 12 inches from each end without scoring conductor insulation.
4. The installer shall strip 1 inch (2.54 cm) of insulation from conductor without scoring the conductor.
5. Install an expansion curl on each wire conductor at all wire connections of all valves and splices.
6. Expansion curls shall be formed by wrapping each wire conductor six (6) turns of wire around a one-inch (1") diameter pipe, then withdrawing pipe.
7. Installer shall bundle like conductors, twist them together, and trim off ½ inch of conductors.
8. Installer shall twist a wire connector in a clockwise direction, and then place a moisture-proof DBR/Y-6 tube over the top making sure connector is fully seated at the top of the tube. Snap the cover completely closed.
9. Installer shall ensure that all connections are mounted in a vertical orientation to eliminate standing water inside the connector.
10. All splices shall be made inside a valve box.

S. Valve Decoders:

1. The valve decoder shall be connected to each automatic valve and two-wire path in accordance with manufacturer's printed instructions.
2. The valve decoders shall be attached to the valve wire and 2-wire path using waterproof connector.
3. The valve decoders shall not share valve wires or common wires between valve decoders.
4. The maximum wire run between the valve decoder and the solenoid shall be 150 feet (150').
5. The contractor is shall be responsible for accurately recording on the as-built drawings, as each decoder is being installed, the address number of the decoder at that location. It is also necessary that it be indicated which remote controls valves controlled by each specified decoder.

T. Sensor Decoder:

1. Install sensor decoder on flow sensor and connect to the 2-wire path in accordance with manufacturer's printed instructions.

U. Grounding/Surge Protection:

1. All surge protection and grounding shall be installed in strict compliance with the manufacturer's printed instructions and in accordance with local, State and Federal codes and requirements.
2. The ground grid components shall be installed with the dimensional relationships shown on the details.
3. Wires, cables, and electronic equipment shall be installed outside “The sphere of Influence” of the grounding electrodes.
4. Install grounding plate at a minimum distance of eight feet (8’) at a right angle from the two-wire path.
5. The ground plates shall be installed to a minimum depth of thirty inches (30”), or below the frost line if it is lower than 30”.
6. Two 50-pound bags of “Earth Contact Material” shall be spread so that it surrounds and the copper plate evenly along its length within a six inch (6”) wide trench. Use one bag only for the installation of 3-foot ground plates. Salts, fertilizers, bentonite clay, cement, coke, carbon, and other chemicals are not to be used to improve soil conductivity because these materials are corrosive and will cause the copper electrodes to erode and become less effective with time. It is important that the Earth Contact material completely surrounds the ground plate and 6” (152 mm) of the insulation of the green wire, as shown in the detail, to minimize corrosion.
7. Connect 6/1 AWG earth grounding, green insulated, solid bare copper wire to the grounding plate with Cadweld connector. Screw type clamps are not acceptable.
8. Install all grounding circuit components in straight lines and simple geometry. No sharp bends or turns shall be allowed. When necessary to bend wires, make sweeping turns as detailed. All grounding and bonding wires of electronic equipment shall be fed through a dedicated one and one-half inch (1 1/2”) plastic sweep ell. “Sweep bends” shall follow the guidelines shown here. The 6/1 AWG bare copper wires shall be installed in as straight a line as possible, and if it is necessary to make a turn or a bend it shall be done in a sweeping curve with a minimum radius of eight inches (8”) and a minimum included angle of 90°. This type of installation, which utilizes a multi-position bus bar, allows for rapid connecting and disconnecting of desired wires to periodically take earth resistance readings of the individual grounding electrodes.
9. The earth-to-ground resistance shall be measured at the time of installation using a “Megger“, or other similar instrument, and the reading shall be no more than 10 Ohms. If the resistance is more than 10 ohms, additional ground plates and “Earth Contact Material” shall be installed using the 100-2002 (www.asic.org, “Design Guides”.) It is required that the soil surrounding copper electrodes, within the Sphere of Influence, be kept at a minimum moisture level of 15% (by weight) always as dry soil does not conduct electricity. ALL GROUNDING COMPONENTS SHALL BE CONNECTED TO THE EQUIPMENT BEFORE ANY OTHER CONNECTION IS MADE.

10. Surge suppression device shall be installed at every 500' of wire cable, located at the nearest line decoder and every line termination point. Install first surge suppression device within 100 feet of central control system. The surge suppression device ground wires shall be connected to a single grounding plate as detailed.
11. Measurement and Testing of Resistance
12. Earth resistance shall be measured and recorded after the installation of the grounding plates, and every three months thereafter for the first year. This data should be used to determine the most critical times of the year, based on soil moisture content and lightning frequency. The resistance shall be tested and recorded every six months thereafter, at these most critical dates, to ensure that proper contact with the soil is maintained always. Resistance measurement shall be made using commercially available instruments, in accordance with the latest requirements of NFPA 780. Follow instrument manufacturer's specific operating instructions.
13. Readings of 5 to 10 ohms are desirable. The effectiveness of the circuit is a function of its impedance, which cannot be measured in the field in a practical manner. Sound practices and proper installation are more important in assuring quality results than this reading.
14. The minimum requirements of the NEC shall be met, which are: A resistance reading of no more than 25 ohms, or a two-electrode ground grid
15. In installations with multiple equipment locations, the resistance readings of like grounding circuits should be compared for consistency. Large variances in readings point to different soil conditions, or soils with varying degrees of moisture content, or improper installation.
16. Record OHM (resistance) readings, date and location of all grounding locations on "Construction Record Drawings".

V. Rain Sensor:

1. Install rain sensor in a location approved by the Architect. Install all wire inside rigid metallic conduit.
2. Furnish and install galvanized metal conduit wherever wire is exposed.
3. Conduit shall not be attached to the outer face of any building wall without the approval of the Architect.

W. Hydrometer:

1. Prior to installation of the meter, the pipeline should be thoroughly flushed.
2. Install the hydrometer with a length of straight pipe before and after the flow sensor.
3. Do not install valves that will cause a restriction directly upstream or downstream of the hydrometer.
4. The hydrometer shall be connected to the controller in accordance with the manufacturer's written specifications.

X. Moisture Sensors:

1. Install moisture sensors in a location approved by the Landscape Architect.
2. The maximum wire run between soil moisture sensor and the controller shall be the same as stated in the two-wire specifications.

3. The soil moisture sensor shall be connected to the two-wire path.
4. The soil moisture sensor shall be buried in an area of average water distribution between two sprinkler heads and placed from the centerline that the sprinklers create.
5. The soil moisture sensor shall be installed in a location representative of the zones that the sensor is controlling.
6. The soil moisture sensor shall be installed two – three inches (2”-3”) below the plant or in the top 1/3 of the root zone.
7. The soil moisture sensor shall be buried with no air pockets around the sensor.
8. The soil moisture sensor shall be marked to avoid damage during aeration.
9. All splices shall be made inside the valve box with a direct burial waterproof connection.

3.7 PRESSURE TESTING

A. Use Hydrostatic pressure test only. Pressure test using air or compressed gas is not acceptable.

B. Approximate number of gallons of water required to fill one hundred feet (100’ for test of mainline pipe are noted below:

2”	20 Gallons

C. Testing should be performed at the lowest elevation along the pipe shall be tested.

D. Solvent weld piping - Cap all risers, bleed air from pipes and perform pressure test upon completion of the main line pipe installation. All main line piping shall be tested at 150 PSI for four (4) hours. During this time, a visual inspection will be made by the Owner’s Representative for leaks.

E. A pressure reading shall be taken after four (4) hours with an allowable pressure drop of 5 psi.

F. When main line pipe is installed in phases and/or segments pressure test each main line segment and/or phase. Pressure test should be performed on sections not longer than 2,500 feet.

G. All leaks shall be repaired by removing the section of pipe at the joint and installing a new section using coupling, mechanical joint or union. After repair, the piping shall be retested until approved by the Owner’s Representative.

H. All lateral piping shall be tested under working conditions and visual inspection made for leaks.

I. Notify the Irrigation Design Consultant and Owner's Representative seventy-two (72) hours prior to testing.

3.8 FLUSHING AND ADJUSTMENT

A. After piping is installed and before sprinklers and spray heads are installed, open control valves and flush out the system with full head of water until pipe is free of all foreign materials.

B. Adjustment of the sprinkler equipment will be done upon completion of the installation, to provide optimum performance and to assure that all sprinklers are properly set to grade.

C. Adjust all automatic valves by means of the flow control stem and verify sprinkler discharge pressure on each lateral zone, with a pitot tube and gauge, to obtain optimum sprinkler performance in accordance with manufacturer's printed instructions.

D. After the irrigation system, has been installed, test the entire system and demonstrate that the entire system meets coverage requirements and automatic controls function properly.

3.9 FINAL REVIEW AND ACCEPTANCE

A. When all irrigation work is completed and the "Construction Record Drawing" has been submitted a final review of the irrigation system will be made by the Owner's Representative, upon written notice requesting such a review. Submit the written notice at least ten (10) days prior to the anticipated review.

B. The Contractor shall have sufficient personnel and either remote control radio, cell phone or other two-way communication device to properly perform final review.

C. Upon final review and acceptance, the Owner's Representative will notify the Owner, in writing, as to final acceptance of the irrigation system. Date of the final acceptance by the Owner is the date beginning the Warranty period.

D. Any irrigation equipment item required under this Contract that is malfunctioning or in need of repair shall be removed and replaced. All replacements shall be of equipment and/or material originally specified.

E. The cost of replacement shall be borne by the Entity performing Work of this Section.

F. Upon acceptance of the entire irrigation system, instruct the Owner's designated personnel in the complete operation of the entire irrigation system.

3.10 CLEAN UP AND PROTECTION

A. Upon completion of all work of this Section, remove and legally dispose of all excess materials resulting from the work operations of this Section.

B. Accumulation of materials for disposal is not permitted. Disposal shall be made as fast as materials accumulate.

C. Adequately protect all paving, surfacing, lawn areas and plant material and restore to original condition all damages resulting from work operations of this Section.

END OF SECTION 328400

SECTION 32 91 00

PLANTING SOIL

PART 1 — GENERAL

1.1 SUMMARY

A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and/or the modification of existing site soil for use as Planting Soil, complete as shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:
1. Modify existing stockpiled native soil.
   a. Modify stockpiled native soil per soil test results.
   b. Blend stockpiled native soil and amendments into Planting Soil Mixes.
   c. Install modified soil for use as Planting Soil.
2. Locate, purchase, deliver and install Imported Topsoil and soil amendments.
3. Fine grade Planting Soil.
4. Install Compost into Planting Soil.
5. Clean up and disposal of all excess and surplus material.

C. Where possible, existing soils shall be prepared to serve at a minimum as either fill soil or horticultural subsoils. If not present in sufficient quantity, fill soil or horticultural subsoil will be imported from an acceptable soil source.

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 31 14 13, SOIL STRIPPING AND STOCKPILING.
2. Section 31 20 00, EARTH MOVING; Establishment of subgrade elevation; grading.
3. Section 32 84 00, PLANTING IRRIGATION.
4. Section 32 92 19, SEEDING AND SODDING.
5. Section 32 93 00, TREES, PLANTS AND GROUNDCOVERS.

1.3 REFERENCES

A. ASTM: American Society of Testing Materials
1. ASTM C136 - Sieve Analysis of Fine & Coarse Aggregates
2. ASTM D2974 - Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

B. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.

C. US Composting Council *www.compostingcouncil.org* *and* http://compostingcouncil.org/admin/wp-content/plugins/wp-*pdfupload/pdf/191/LandscapeArch_Specs.pdf.*

D. *Methods of Soil Analysis*, as published by the Soil Science Society of America (http://www.soils.org/).

E. Up by Roots: healthy soils and trees in the built environment. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

1.4 DEFINITIONS

A. Amendment: material added to Topsoil to produce Planting Soil Mixes, or to adjust chemical and biological properties of stockpiled native soil. Amendments are general soil amendments, fertilizers, biological, and pH amendments.

B. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting, and further defined in this specification.

C. Compost: well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.

D. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).

E. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, and further defined in this specification.

F. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes other suitable devices, and further defined in this specification, and further defined in this specification.

G. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and further defined in this specification.

H. Installed soil: Planting Soil and existing site soil that is spread and or graded to form a planting soil, and further defined in this specification.

I. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.

J. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top, and further defined in this specification.

K. Soil Horizons: as defined in the USDA National Soil Survey Handbook http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242.

L. Soil Tilling: Loosening the surface of the soil to the depths specified with a **rotary tine tilling machine, roto tiller, (or spade tiller)**, and further defined in this specification**.**

M. Stockpiled Native Topsoil: Soil removed and stockpiled according to the requirements of Section 311413, SOIL STRIPPING AND STOCKPILING.

N. Subgrade: surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing Planting Soil.

O. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.

1.5 SUBMITTALS

A. Submit all product submittals at least eight weeks prior to the start of soil work.

B. Product Data and Certificates: Submit product data and material certificates indicating that the product meets the requirements of the specification for approval.
   1. Compost: Submit the manufacturer's particle size and pH analyses and certificate of length of composting period to confirm product meets specified requirements.

   2. Coarse Sand: Submit the manufacturer's particle size and pH analyses confirming that product meets specified requirements.
      a. Particle size distribution (percent passing the following sieve sizes):
         3/8 inch (9.5 mm)
         No 4 (4.75 mm)
         No 8 (2.36 mm)
         No 16(1.18 mm)
         No 30 (.60 mm)
         No 50 (.30 mm)
         No 100 (.15 mm)
         No 200 (.075 mm)

C. Samples: Submit representative samples to the Landscape Architect for approval. Label samples to indicate product, specification number, and characteristics. Samples will be reviewed for appearance only. Delivered materials shall closely match samples. Samples of all products shall be submitted eight weeks before the installation of Planting Soil Mixes.
   1. Stockpiled Native Topsoil: Provide a representative sample with testing data that includes recommendations for amendments to adjust the soil biology and chemistry to meet specified requirements as necessary.

   2. Imported Topsoil (if using): Provide a representative sample with testing data that certifies that the product meets specified requirements.

   3. Coarse Sand: Provide a one-pound samples with manufacturer's literature and material certification that the product meets the requirements.

   4. Compost: Provide a one-pound sample with manufacturer's literature and material certification that the product meets the requirements.

D. Test reports: Submit certified test reports from an approved soil-testing laboratory.
   1. Submit Stockpiled Native Topsoil and Topsoil for testing at least 8 weeks before scheduled installation of Planting Soil Mixes. Do not proceed with mixing Planting Soil Mixes until Topsoil, Coarse Sand and Compost have been approved. Submit Base Planting Soil for testing no more than 2 weeks after approval of these materials.

   2. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.

   3. Provide the following other soil properties:
      a. pH and buffer pH.
      b. Percent organic content by oven dried weight.
      c. Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
      d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.

e. Cation Exchange Capacity (CEC).

4. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Owner's Representative. All soil testing will be at the expense of the Contractor.

1.6 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape contractor experienced with soil preparation for extensive landscapes with the capabilities/equipment for preparing site soils as directed in this specification. Use adequate numbers of skilled workers who are trained in the necessary crafts and who are completely familiar with the specified requirements and methods needed for the proper performance of the work of this Section:
1. Contractor shall submit written documentation of at least five years of contracting and landscape construction experience completing projects of similar scope, complexity and value.

B. Soil Testing Laboratory Qualifications: Laboratories shall be independent, with the experience and capability to conduct the testing indicated and specialize in USDA agricultural soil testing, Planting Soil Mixes, and the types of tests to be performed. The laboratory shall use the appropriate procedures for soils, sands and organic amendments as published in ASTM Methods, Chemical Soil Testing Procedures for the Northeastern Unites States (Bulletin #493) and/or The Composting Council Recommended Testing Procedures for Compost. Geotechnical engineering testing labs shall not be used.

C. Soil Compaction Testing: following installation or modification of soil, test soil compaction with a penetrometer as follows:
1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
a. Penetrometer shall be AgraTronix Soil Compaction Meter distributed by Ben Meadows, www.benmeadows.com or approved equal.
b. Moisture meter shall be "general digital soil moisture meter" distributed by Ben Meadows, www.benmeadows.com or approved equal.

2. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.

3. The penetrometer readings shall be within 20% plus or minus approved compaction rates.

D. Regulatory Requirements: Comply with applicable requirements of laws, codes, and regulations of federal, State and local authorities having jurisdiction over Work.

1.8 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, they shall remain responsible for plant material under the warrantee clause of the specifications.

2. This specification requires that all Planting Soil and Irrigation work be completed and accepted prior to the installation of any plants.

1.9 DELIVERY, STORAGE AND HANDLING

A. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity.

B. Protect all soil and soil stockpiles from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.

C. Imported Topsoil shall be delivered at our near optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698). Do not deliver or place materials in an excessively moist condition (beyond 2 percent above optimum compaction moisture content).

D. Deliver all chemical amendments in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in a weather protected enclosure.

E. Bulk material: Coordinate delivery and storage with Owner's Representative and confine materials to neat piles in areas acceptable to Owner's Representative.

PART 2 — PRODUCTS

2.1 TOPSOIL

A. Topsoil shall be Stockpiled Native Topsoil salvaged prior to construction activities. Stockpiled Native Topsoil may be modified to meet the listed requirements. If sufficient quantities of Stockpiled Native Topsoil are unavailable, use an Imported Topsoil that meets the specified requirements.

B. Topsoil definition: Fertile, friable soil containing less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. The percent (%) of the above objects shall be controlled by source selection not by screening the soil. Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds.

C. Topsoil shall meet the following physical and chemical criteria:
1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.
2. pH value shall be between 5.5 and 7.5.
3. Percent organic matter (OM): 2.0-5.0%, by dry weight.
4. Soluble salt level: Less than 2 mmho/cm.
5. Soil chemistry suitable for growing the plants specified.

D. Topsoil shall be a harvested soil from fields or development sites. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, Composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall not be acceptable.

E. Topsoil shall NOT have been screened and shall retain soil peds or clods larger than 2 inches in diameter throughout the stockpile after harvesting.

F. Stockpiled Native Topsoil Testing: One composite soil sample will be collected from every 100 cubic yards of stockpiled soil. Samples will be collected using clean stainless steel implements (spoon) from six locations of

each stockpiled soil, from approximately 12 inches or deeper in the stockpile, and placed in plastic zip-lock bags labeled with a unique identifier for the soil material, and date of collection.

2.2 COMPOST

A. Compost shall be a stable, humus-like material produced from the aerobic decomposition and curing of organic vegetative residues derived from feedstock consisting of woody stems, leaves, grass cuttings, and livestock manure (up to 10 percent of the compost mix by volume). **Compost feedstock shall not include municipal or industrial waste sludges, food wastes, or treated lumber products.** The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices with no visible free water or dust, with no unpleasant odor.

Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria or equal for Class I or II stable, mature product. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf

B. Compost shall comply with the following parameters:
1. pH: 5.5 - 8.0.
2. Soil salt (electrical conductivity): maximum 5 dS/m (mmhos/cm).
3. Moisture content %, wet weight basis: 30 – 60.
4. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.
5. Stability carbon dioxide evolution rate: mg CO_2-C/ g OM/ day < 2.
6. Solvita maturity test: > 6.
7. Physical contaminants (inerts), % dry weight basis: <1%.
8. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
9. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32.

2.3 COARSE SAND

A. Clean, washed, sand, free of toxic materials
1. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.

2. Coarse Sands shall be clean, sharp, natural Coarse Sands free of limestone, shale and slate particles. Manufactured Coarse Sand shall not be permitted.

3. pH shall be lower than 7.0.

4. Provide Coarse Sand with the following particle size distribution:

Sieve	Percent passing
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95-100
No 8 (2.36 mm)	80-100
No 16 (1.18 mm)	50-85
No 30 (.60 mm)	25-60
No 50 (.30 mm)	10-30
No 100 (.15 mm)	2-10
No 200 (0.75 mm	2-5

2.4 LIME

A. Lime shall be added to Stockpiled Native Topsoil to adjust pH levels as required.

B. Lime shall be ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.
2. Provide lime in form of dolomitic limestone.

C. Provide manufacturer's literature and material certification that the product meets the requirements.

2.5 PLANTING SOIL MIXES

A. General requirements: Planting Soil Mixes comprise Topsoil, Coarse Sand and/or Compost blended to an even, homogenous mix. Blend prior to installation by mixing Coarse Sand and Compost together first and then adding to Topsoil. Mix with a loader bucket to loosely incorporate the Topsoil into the Coarse Sand/Compost Mix. Do not over mix. Do not mix with a soil blending machine. Do not screen the soil. Clumps of Soil, Compost and Coarse Sand will be permitted in the final mixes.

B. Base Planting Soil: Base Planting Soil shall be the primary soil that will be used for preparation of planting mixes.

1. The approximate Mix ratio shall be:

Mix component	% by moist volume
Topsoil	45-50%
Coarse sand	40-45%
Compost	10%

2. Base Planting Soil shall conform to the following qualities:
   a. Final tested organic matter of between 2.5 and 4.0% by dry weight.
   b. pH: 6.5 – 7.8.
   c. Total nitrogen (all forms): 500 to1500 mg/kg soil
   d. Available nitrogen (NH4 and NO3): 50 to 200 mg/kg soil
   e. Available P: 20 to 40 mg/kg

C. Tree & Shrub Soil: Tree & Shrub Soil shall consist of 4 parts Base Planting Soil blended with 1 part compost, by volume.

D. Bioretention Soil: Bioretention Soil shall consist of 3 parts Base Planting Soil blended with 1 part compost, by volume.

PART 3 — EXECUTION

3.1 EXAMINATION

A. Prior to installation of Planting Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the any under drain lines as shown on the drawings.

2. Confirm that all areas to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.

3. Confirm that no adverse drainage conditions are present.

4. Confirm that no conditions are present which are detrimental to plant growth.

5. Confirm that utility work has been completed per the drawings.

6. Confirm that irrigation work, which is shown to be installed below prepared soil levels, has been completed.

B. If unsatisfactory conditions are encountered, notify the Owner's Representative immediately to determine corrective action before proceeding.

3.2 PREPARATION

A. Excavate to the proposed subgrade of all soil profiles. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain all required angles of repose of the adjacent materials as shown on the drawings.

B. Remove all construction debris and material including any construction materials from the subgrade.

C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.

D. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.

2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

3.3 SUBGRADE LOOSENING

A. Prior to the installation of any Planting Soil, till or scarify the subgrade by dragging the teeth of a loader bucket or backhoe across the soil surface in two directions. Till or scarify to the full depth indicated in the Soil Profile drawings.

B. Spread a layer of Compost over the area and till into the scarified profile.

C. Protect the loosened area from traffic. Do not allow the loosened subgrade to become compacted. In the event that the loosened area becomes overly compacted, till or scarify the area again prior to installing the Planting Soil.

D. Do not scarify within drip line of existing trees to be retained.

3.4 PLANTING SOIL INSTALLATION

A. All equipment utilized to install or grade Planting Soil shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.

B. Install the Planting Soil in lifts less than 12" to the required depths. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil.

C. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of the each bed area.

D. Where possible place large trees first and fill Planting Soil around the root ball.

E. Installing soil with soil or mulch blowers or soil slingers shall not be permitted due to the over mixing and soil ped breakdown cause by this type of equipment.

F. Placement of soil by back-blading is not acceptable. Back-blading causes sealing of the soil surface and inhibits air and moisture from penetrating the planting soil mix.

G. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with the paragraph “Compaction Reduction” (section 3.9) in the event that soil becomes over compacted.

H. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the compost material. A minimum settlement of approximately 10 - 15% of the soil depth is expected. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of volume All grade increases are assumed to be as measured prior to addition of surface Compost till layer, mulch, or sod.

3.5 COMPACTION

A. Compact each lift with mechanical compaction equipment to the such that a penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

B. Maintain moisture conditions within the Planting Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Planting Soil becomes wet. Apply water if the soil is overly dry. Do not place planting soils on wet or frozen subgrade.

C. Provide adequate equipment to achieve consistent and uniform compaction of the Planting Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction.

D. Do not pass motorized equipment over previously installed and compacted soil.
   1. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

3.6 OVER COMPACTION REDUCTION

A. Any soil that becomes compacted to a density greater than the specified density shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.

B. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.
   1. a rate of one test per 5,000 square feet for each type of material placed.

3.7 FINE GRADING

A. The Owner’s Representative shall approve all rough grading prior to the installation of Compost, fine grading, planting, and mulching.

B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Planting Soil Installation, to anticipate settlement over the first year.

C. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.

D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Owner's Representative in the event that conditions make it impossible to achieve positive drainage.

E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.

F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

G. Restore all grades after the installation of plants.

3.8 INSTALLATION OF COMPOST TILL LAYER

A. After Planting Soil is installed and just prior to the installation of shrub or groundcover plantings, spread 3 inches of Compost over the beds and roto till into the top 4 inches of the Planting Soil.

B. This step will raise grades slightly above the grades required in paragraph "Fine Grading". This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph "Planting Soil installation" must still be accounted for in the setting of final grades.

3.9 CLEAN-UP

A. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds.
   1. Make all repairs to grades, ruts, and damage to work at the site.
   2. Remove and dispose of all excess Planting Soil, subsoil, mulch, packaging, and other material brought to the site by the Contractor.

3.10 PROTECTION

A. The Contractor shall protect installed Planting Soil from damage including contamination and over compaction due to other soil installation, planting operations, and operations by other Contractors or trespassers.

B. Maintain protection during installation until final acceptance. Utilize fencing and matting as required or directed to protect the finished soil work. Treat, repair or replace damaged Planting Soil immediately.

C. Within the installation warranty period repair and re-establish grades to the specified tolerances. Repair soil that has been eroded, rutted, settled or compacted due to construction traffic or weather conditions.

D. Where erosion or settling occurs before or after walkway or sidewalk construction occurs and final acceptance; backfill with approved planting soil type and compact to specified rates acceptable to the Landscape Architect.

3.11 FINAL REVIEW

A. At the end of the plant warranty and maintenance period, (see Specification section - Planting) the Owner's Representative shall observe the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.

1. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.

END OF SECTION

SECTION 32 92 19

SEEDING AND SODDING

PART 1 — GENERAL

1.1 SUMMARY

A. Provide seeded and sodded areas as shown and specified. This work includes:
   1. Sodding turgrass at areas to receive irrigation.
   2. Seeding turfgrass at non-irrigated areas.

1.2 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

   1. Section 31 20 00, Earth Moving; Establishment of subgrade elevation; grading.
   2. Section 32 84 00, Planting Irrigation.
   3. Section 32 91 00, Planting Soil.

1.3 REFERENCES

A. AOSA — Association of Official Seed Analysis:
Rules for Testing Seeds, Journal of Seed Technology, Current Edition.

B. FSA — Federal Seed Act.

C. ASTM — American Society for Testing Materials:
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

1.4 SUBMITTALS

A. Submit sod vendor's certification for required grass mixture.

B. Submit sod source for Landscape Architect’s approval.

C. Submit seed vendor's certification for required grass seed mixture, indicating percentage by weight, and percentages of purity, germination, and weed seed for each grass species.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work, including the FSA.
   2. Provide for inspections and permits required by Federal, State and local authorities in furnishing, transporting, and installing materials.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Labeling:
   1. Furnish standard products in unopened manufacturer’s standard containers.

2. Seed analysis meeting requirements of the AOSA Rules for Testing Seeds shall be attached to outside as well as inside container, showing species, PLS percentage, germination, purity, inert seed, weed seed, other crop seed, name of certified testing agency and date of test.
3. No seed will be accepted unless test date is within 8 months of planting date.

B. Digging Sod:
1. Sod shall not be dug at the nursery or approved source until ready to transport sod to the site of the work or acceptable storage location.

2. Before stripping, sod shall be mowed at a uniform height of 2-1/2 inches.

3. Cut sod to specified thickness and to standard width and length desired.

C. Transportation of Sod:
1. Sod transported to the project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury. Closed vehicles shall be adequately ventilated to prevent overheating of the sod.

2. Evidence of inadequate protection following the digging, carelessness while in transit, or improper handling or storage, shall be cause for rejection.

3. Sod shall be kept moist, fresh, and protected at all times. Such protection shall encompass the entire period during which the sod is in transit, being handled, or is in temporary storage.

4. Upon arrival at the temporary storage location or the site of the work, sod shall be inspected for proper shipping procedures. Should the sod be dried out, the Landscape Architect will reject the sod. When sod has been rejected, the Contractor shall at once remove it from the area of the work and replace it with acceptable material.

5. Unless otherwise authorized by the Landscape Architect, the Contractor shall notify the Landscape Architect and Owner's Representative at least two working days in advance of the anticipated delivery date of sod. Certificate of Inspection when required shall accompany each shipment.

D. Handling and Storage of Sod:
1. Sod shall be handled with extreme care to avoid breaking or tearing strips.

2. Sod shall not be stored for longer than 30 hours prior to installation. Sod shall be stored in a compact group and shall be kept moist. Sod shall be prevented from freezing.

3. Sod that has been damaged by poor handling or improper storage will be rejected by the Landscape Architect or Owner's Representative.

1.7 PROJECT CONDITIONS

A. Restrict traffic from seeded areas until grass is established. Erect signs and barriers as required.

B. Work notification: Notify Landscape Architect and Owner's Representative at least 7 working days prior to start of sodding operations.

C. Provide hose and lawn watering equipment as required.

D. Temporarily seed within 15 days any denuded areas which may not be at final grade, but which will remain dormant (undisturbed) for longer than 60 days.

1.8 WARRANTY

A. Warranty Period: Warrant that grasses shall be in a healthy and flourishing condition of active growth at the end of the next growing season following the date of Final Completion.

B. Condition: Free of dead or dying patches; areas shall show foliage of normal density, size and color.

C. Delays: Delays in completion of planting operations which extend the planting into more than one planting season shall extend the Warranty period correspondingly.

D. Coverage: Warrant growth and coverage of sodded or seeded planting to the effect that a minimum of 90 percent of the area planted shall be covered with specified planting after one full growing season with no bare spots greater than 1 square foot.

E. Replacement: As soon as weather conditions permit, replant at no additional cost to the Owner, areas of dead turfgrass and areas where turfgrass is not in a vigorous, thriving condition, during and at the end of the Warranty Period.

F. Requirements for Replacement Work: Apply requirements of this Specification to replacement Work.

PART 2 — PRODUCTS

2.1 MATERIALS

A. Turfgrass Sod:

1. Superior sod grown from certified, high quality seed of known origin or from plantings of certified grass seedlings or stolons. It shall be inspected by the certification agency of the state in which it is grown to assure satisfactory genetic identity and purity, overall high quality and freedom from noxious weeds as well as excessive quantities of other crop and weedy plants at time of harvest. All seed or original plant material in mixture must be certified. Turfgrass sod shall meet the published state standards for certification.

    a. Sod shall be a mixture of four or five current and improved bluegrass varieties found in the top 25% of the NTEP (National Turfgrass Evaluation Proceedings), with last two tests spanning over 8 years. Mixture shall contain approximately equal proportions of each hybrid component.

2. Sod shall be nursery grown on cultivated mineral agricultural soils. Sod shall have been mowed regularly and carefully, and otherwise maintained from planting to harvest.

3. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 5/8 inch, plus or minus 1/4 inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch.

4. Strip Size: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 inch on width, and plus or minus 5% on length. Broken strips and torn and uneven ends will not be acceptable.

5. Strength of Sod Strips: Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape if suspended vertically when grasped in the upper 10% of the section.

6. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

7. Time Limitations: Sod shall be harvested, delivered, and transplanted within a 36 hour period unless a suitable preservation method is approved prior to delivery. Sod not transplanted within this period shall be inspected and approved by the Landscape Architect prior to its installation.

8. Thatch: Sod shall be relatively free of thatch. A maximum of 1/2 inch (uncompressed) thatch will be permitted.

9. Diseases, Nematodes, and Insects: Sod shall be free of diseases, nematodes, and soil-borne insects. State Nursery and Plant Materials Laws require that all sod be inspected and approved for sale. The inspection and approval must be made by the State Agricultural Department, Office of the State Entomologist.

10. Weeds: Sod shall be free of objectionable grassy and broad leaf weeds.

B. Turfgrass seed: Fresh, clean, and new crop seed mixture.

1. Seed shall be composed of the following varieties, and mixed by an approved method to the specified proportions by weight and tested to minimum percentages of purity and germination.

Blend: 80% Tall Fescue - Category 1
20% Kentucky Blue grass - Category 1

Rate: Tall Fescue - 220 lbs per acre
Kentucky Bluegrass - 40 lbs per acre

2. Seed shall be free of Poa annua, bent grass, and noxious weed seed free

C. Water: Free of substances harmful to sod growth. Hoses or other methods of transportation furnished by Contractor.

2.2 PLANTING SOILS

A. Turf soil mixes shall be as specified in Section 32 91 00, PLANTING SOIL.

PART 3 — EXECUTION

3.1 PLANTING SEASON

A. Perform seeding and sodding work as follows:

Material	Planting Season	
	Spring	Fall
Sod	3/15 to 5/15	8/15 to 10/15
Seed	starting 3/15	ending 10/15

B. Planting shall only be performed when weather and soil conditions are suitable for planting the material specified in accordance with locally accepted practice.

C. Planting season may be extended with the written permission of the Landscape Architect.

3.2 EXAMINATION AND COORDINATION

A. Examine site and verify that conditions are suitable to receive Work and that no conditions are present which would cause defective installation of products or cause latent defects in workmanship and function.

B. Notification of Unsuitable Conditions: Before proceeding with Work, notify Owner's Representative in writing of unsuitable conditions.

C. Do not start sodding work until unsatisfactory conditions are corrected.

D. Coordinate with the work of Section 32 84 00, PLANTING IRRIGATION.

3.3 PREPARATION

A. Verify soil preparation Work is complete in accordance with Section 32 91 00, PLANTING SOIL, and in accordance with the Drawings.

B. Verify finish grading Work is complete and has been accepted by the Landscape Architect.

3.4 INSTALLATION

A. Sodding:

1. Edges of the sodded areas shall be smooth, and all sodded areas shall conform to the design cross sections and grade. At edges adjacent to curbs, paved areas, etc., top surface of earth in sod shall be 1/2 in. below adjacent hard surface.

2. Sod shall be placed and all sodding operations completed within 72 hours following stripping from sod source bed.

3. Surface of completed sodded area shall be smooth. Sod shall be laid edge-to-edge, with tight-butted, staggered joints. Sod shall be carefully placed to insure that it is neither stretched nor overlapped. After laying, sod shall be pressed firmly into contact with sod bed by tamping, to eliminate air pockets. Sod shall be laid off boards in order to prevent damage to finish grade or sod.

4. Immediately after sodding operations have been completed, entire surface shall be compacted with a cultipacker roller or other approved equipment weighing 100 to 160 lb./ft. of roller.

5. Completed sod areas shall immediately be watered sufficiently to uniformly wet the soil to at least 1 in. below the bottom of sod bed.

B. Seeding:

1. Seed immediately after preparation of bed and once the area is cleared of all vegetation, trash, debris and stones larger than 1/2" in diameter or length.

2. Seed indicated areas within limit of construction and areas adjoining contract limits disturbed as a result of construction operations.

3. Perform seeding operations when the soil is dry and when winds do not exceed 5 miles per hour velocity.

4. Apply seed with a rotary or drop type distributor. Install seed evenly by sowing equal quantities in 2 directions, at right angles to each other.

5. Sow grass seed at the specified rate for the type of seed being used.

6. After seeding, rake or drag surface of soil lightly to incorporate seed into top 1/8" of soil. Roll with a light lawn roller.

3.5 PROTECTION

A. Traffic:
1. Do not operate any equipment or allow any foot traffic over the seeded and sodded areas until grass is established enough to prevent soil from eroding.
2. Do not operate any equipment on seeded or sodded areas until ground is firm enough that ruts will not occur.

B. Utilize fencing as necessary or directed by the Landscape Architect or Owner's Representative to protect the finished seeding and sodding work. Treat, repair or replace damaged areas immediately.

3.6 MAINTENANCE

A. Except as otherwise specified below, maintenance shall include all operations required to produce an established lawn, including but not limited to:
Fertilizing
Mowing
Replanting
Watering
Weeding

B. Maintenance of seeded and sodded areas shall begin upon completion of seeding sodding and shall continue for 45 days thereafter, unless sodding is not completed until after September 15, in which case maintenance shall continue until the June 15 following.

C. Water daily to maintain adequate surface soil moisture for proper seed germination and root establishment. Continue daily watering for not less than 30 days. Thereafter apply 1/2" of water twice weekly until acceptable.

D. Mowing shall not be attempted until the sod is firmly rooted and securely in place. Mow lawn areas as soon as lawn top growth reaches three inches height. Cut back to two and one-half inches in height. Repeat mowing as required to maintain specified height. At no time shall more than 1/3" of the grass blade length be removed during mowing.

E. Weeds and growth other than varieties of grass named in grass seed formula shall be removed. Removal may be accomplished by use of suitable herbicides or by physical removal, in which case top growth and roots shall both be removed, and bare spots exceeding specified limits shall be reseeded.

3.7 ACCEPTANCE

A. Sodding:
1. Roots are thoroughly knit to the soil.
2. Absence of visible joints on sodded areas.

B. Seeding:
1. The Landscape Architect or Owner's Representative will inspect all work once there is a uniform, vigorous stand of weed free grass 2 1/2" tall, with 90% evenly distributed coverage and without bare areas.

2. Once seeding is in conformance with the contract documents, the project will be accepted on the date of inspection. Upon acceptance of the project, maintenance becomes the responsibility of the Owner.

3. If the seeding is not in conformance, the contractor shall complete non-conforming items prior to a follow-up inspection by the Landscape Architect or Owner's Representative. Acceptance will be confirmed in writing.

4. Acceptance of the seeding shall be for general conformance to quality and shall not relieve the Contractor of responsibility for full conformance to the Contract Documents, including correct species.

3.8 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment.

END OF SECTION

SECTION 32 93 00

TREES, PLANTS, AND GROUND COVERS

PART 1 — GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of plant material shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:
1. Locate, purchase, deliver and install all specified plants.
2. Water all specified plants.
3. Mulch, fertilize, stake, and prune all specified plants.
4. Clean up and disposal of all excess and surplus material.

C. Related Sections: Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
1. Section 05 59 01, Metal Edging.
2. Section 31 20 00, Earth Moving; Establishment of subgrade elevation; grading.
3. Section 32 84 00, Planting Irrigation.
4. Section 32 91 00, Planting Soil.
5. Section 32 92 19, Seeding and Sodding.

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
1. American National Standards Institute, Inc. (ANSI):
a. Z60.1 American Standard for Nursery Stock (Sponsor: American Association of Nurserymen, Inc.)
b. A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts, with particular attention to:
a. A300 Part 5 *Construction Management*
b. *A300 Part 6 Planting and Transplanting*
c. A300 Part 8 *Root Management*

2. "Hortus Third", A Concise Dictionary of Plants Cultivated in the United States and Canada, Cornell University, L.H. Bailey Hortorium, MacMillian Publishing Co., New York, NY.

3. International Society of Arboriculture (ISA), Champaign IL:
a. Best Management Practices – Tree Planting, most current edition.
b. Glossary of Arboricultural Terms, most current edition.

1.4 DEFINITIONS

A. Defective plant: Any plant that fails to meet the plant quality requirement of this specification.

B. Field grown trees (B&B): Trees growing in field soil for at least 12 months prior to harvest.

C. Root ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.

D. Root ball package. The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for shipping.

E. Root collar (root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.

F. Stem: The trunk of the tree.

G. Stem girdling root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as Stem Girdling that have, or are likely to have in the future, root to trunk bark contact.

H. Structural root: One of the largest roots emerging from the root collar.

1.5 SUBMITTALS

A. See contract general conditions for policy and procedure related to submittals.

B. Product data: Submit manufacturer product data and literature describing all products required by this section to the Client, Owner's Representative, or Landscape Architect for approval. Provide submittal eight weeks before the installation of plants.

C. Plant growers' certificates: Submit plant growers' certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the Client, Owner's Representative, or Landscape Architect for approval. Provide submittal eight weeks before the installation of plants.

D. Close out submittals: Submit to the Client, Owner's Representative, or Landscape Architect for approval

1.6 SOURCE QUALITY CONTROL

A. Identification of plant materials shall be as named in "Hortus Third".

B. Selection of Plant Materials: Submit to the Landscape Architect the names and locations of nurseries proposed as sources of acceptable plant material. Inspect all nursery materials to determine that the materials meet the requirements of this section. Proposed materials shall be flagged at the nurseries by the Contractor prior to viewing by the Landscape Architect.

1. Schedule with the Landscape Architect and Client a time for viewing trees and shrubs at the nursery. Trips to nurseries shall be efficiently arranged to maximize viewing time. A minimum of six weeks shall be allowed for this viewing prior to time plants are to be dug.

2. Landscape Architect may choose to attach seal to each plant, or representative samples.

3. Where requested by the Client, Owner's Representative, or Landscape Architect, photographs of plant material or representative samples of plants shall be submitted.

4. Viewing and/or sealing of plant materials by the Landscape Architect at the nursery does not preclude the Client, Owner's Representative, or Landscape Architect's right to reject material at the site of planting.

1.7 SCHEDULING

A. Schedule a meeting with the Client, Owner's Representative, and Landscape Architect to review any questions the Contractor may have regarding the work, and to develop an agreed upon planting schedule.
   1. Planting Schedule: Planting may commence as soon as the ground has thawed at the nursery and at the site of planting, and weather conditions make it practical to work both at the nursery and at the site. Acceptable planting dates vary by plant material. As a general rule the following guidelines apply:
      a. Spring Planting End Date: June 15 for Evergreen Trees and Shrubs, June 30 for Deciduous Trees and Shrubs.
      b. Fall Planting Period: September 15 – December 1.
      c. Herbaceous Plants may be installed in summer months by approval by Client, Owner's Representative, or Landscape Architect.
   2. Regardless of the dates specified above, planting shall only be performed when weather and soil conditions are suitable for planting the material specified in accordance with locally accepted practice.
   3. Planting season may be extended only with the written permission of the Client, Owner's Representative, or Landscape Architect.

B. Document meeting and submit meeting notes for record purposes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Digging Plant Material: Plants shall not be dug at the nursery or approved source until the Contractor is ready to transport them from their original locations to the site of the work or acceptable storage location.

B. Transportation of Plant Material: Plants transported to the project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury to the plants. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. Plants shall not remain in darkened enclosed trailer for more than 48 hours cumulative.
   1. Plants shall be kept moist, fresh, and protected at all times. Such protection shall encompass the entire period during which the plants are in transit, being handled, or are in temporary storage.
   2. Unless otherwise authorized by the Landscape Architect, notify the Client, Owner's Representative or Landscape Architect at least three working days in advance of the anticipated delivery date of any plant material. A legible copy of the bill of lading, showing the quantities, kinds, and sizes of materials included for each shipment shall be furnished to the Architect.

C. Storage: Unless specific authorization is obtained from the Landscape Architect, plants shall not remain on the site of work longer than three days prior to being planted.
   1. Plants that are not planted immediately shall be protected as follows:
      a. Earth balls shall be kept appropriately moist and their solidity carefully preserved.
      b. Plants shall not be allowed to dry out or freeze.
   2. Both the duration and method of storage of plant materials shall be subject to the approval of the Landscape Architect.

D. Handling of Plant Materials: Exercise care in handling plant materials to avoid damage or stress.

1.9 REJECTION OF MATERIALS

A. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage, shall be cause for rejection.

B. Upon arrival at the temporary storage location or the site of the work, plants shall be inspected for proper shipping procedures. Should the roots be dried out, large branches be broken, balls of earth broken or loosened, or areas of bark be torn, the Client, Owner's Representative or Landscape Architect will reject the injured plant.

C. When a plant has been rejected, remove it from the area of the work within 3 days and replace it with one of the required size and quality.

1.10 ACCEPTANCE

A. The Architect will inspect all work for Substantial Completion upon written notice of completion. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Acceptance of plant material by the Architect will be for general conformance to specified size, character, and quality, and shall not diminish responsibility for full conformance to the Contract Documents.

C. Upon completion and reinspection of all repairs or renewals necessary in the judgement of the Architect, the Architect will recommend to the Owner that acceptance of the work of this Section be given.

D. Acceptance in Part
1. The work may be accepted in parts when it is deemed to be in the Owner's best interest to do so, and when permission is given to the Contractor in writing to complete the work in parts.
2. Acceptance and use of such areas by the Owner shall not waive any other provisions of this Contract.

1.11 MAINTENANCE

A. Contractor shall maintain plant material until the completion of guarantee period and Final Acceptance of work, as described in Part 3 of this Section.

1.12 GUARANTEE

A. Guarantees:
1. Trees larger than 4 in. caliper shall be guaranteed for a period of two (2) years after the date of Acceptance by the Owner.
2. All other plants shall be guaranteed for a period of one (1) year after the date of Acceptance by the Owner.
3. When the work is accepted in parts, the guarantee periods shall extend from each of the partial acceptances to the terminal date of the last guarantee period. Thus, all guarantee periods terminate at one time.

B. Plants shall be healthy, free of pests and disease, and in flourishing condition at the end of the guarantee period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, and color.

C. Replace dead plants and all plants not in a vigorous, thriving condition, as determined by the Architect during and at the end of the guarantee period, without cost to the Owner, as soon as weather conditions permit and within the specified planting period.

1. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Specification.

2. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

3. The guarantee of all replacement trees larger than 4 in. caliper shall extend for an additional two (2) year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended guarantee period, the Owner may elect one more replacement or credit for each item.

4. The guarantee of all other replacement plants shall extend for an additional one (1) year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended guarantee period, the Owner may elect one more replacement or credit for each item.

D. Staking and guying materials, and tree wrap and ties shall be removed in accordance with Section

1.13 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, the Landscape Architect will, upon written notice of end of guarantee period inspect the work for Final Acceptance. Request shall be received at least ten calendar days before the anticipated date for Final Inspection.

B. Upon completion and reinspection of full repairs or replacements necessary in the judgment of the Landscape Architect at that time, the Landscape Architect will recommend to the Owner that Final Acceptance of the Work of this Section be given.

PART 2 — PRODUCTS

2.1 PLANTS

A. Except as otherwise specified, size and grade of plant materials shall conform to ANSI Z60.1. In no case shall ball size be less than 11 in. in diameter for each inch of caliper.

B. Plants shall be healthy and vigorous, free of disease, insect pests and their eggs, and larvae.

C. Plants shall be free of physical damage such as scrapes, broken or split branches, scars, bark abrasions, sunscalds, fresh limb cuts, disfiguring knots, or other defects. These defects shall not interrupt more than 10% of the circumference of the plant cambium.

D. All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates required by law shall accompany each shipment of plants.

E. Plants shall meet the sizes indicated on the Plant List. Plants larger or smaller than specified may be used only if accepted by the Landscape Architect.

F. Where a size or caliper range is stated, at least 50% of the material shall be closer in size to the top of the range stated.

G. Plants shall not be pruned before delivery.

H. No species shall be substituted without written approval of the Landscape Architect.

I. Trees and shrubs shall have outstanding form; symmetrical, heavily branched with an even branch distribution, densely foliated and/or budded, and a strong, straight, distinct leader where this is characteristic of species. Plants shall possess a normal balance between height and spread. The Client, Owner's Representative, or Landscape Architect will be the final arbiter of acceptability of plant form.

J. All trees and shrubs shall be labeled. Labels shall be durable and legible, stating the correct plant name and size in weather-resistant ink or embossed process. Labels shall be securely attached to plants prior to delivery to the site, being careful not to restrict growth.

K. Plants indicated as "B&B" shall be balled and burlapped. Burlap and twine material shall be biodegradable and shall completely cover the root ball.

L. Root system quality: Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting plant health.
1. Plants shall have a well-developed fibrous root system. Root distribution shall be uniform throughout the root ball.

2. The root collar shall be within the upper 2 inches of the substrate/soil.

3. The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.

4. Container grown plants shall have a well-established root system reaching the sides of the container to maintain a firm ball, but shall not have excessive root growth encircling the inside of the container.

M. Landscape Plugs
1. Plants specified as "LP" shall be supplied in flats with a minimum cell depth of 4", cell width of 2" and a minimum cell volume of $10in^3$

2. Supplier to be Northcreek Nurseries, 388 North Creek Road, Landenberg, PA 19350
Tel.: (610) 255-010; or approved equal.

N. Vines and ground covers: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

2.2 PLANTING SOILS

A. Refer to Section 32 91 00 PLANTING SOIL.

2.3 COMPOST, FERTILIZER AND SOIL AMENDMENTS

A. Refer to Section 32 91 00 PLANTING SOIL.

2.4 WATER

A. Water shall be suitable for irrigation and shall be free from ingredients harmful to plant life.

2.5 MULCH

A. Chipped or tub-ground hardwood that has been composted at least six months prior to application in a manner to sufficiently suppress disease organisms and weed seeds and provide visual indications that it has begun to decay, maximum 1-inch by 3-inch size pieces and no more than 25 percent of the pieces less than 1/4-inch by 1/4-inch.

2.6 GUYING MATERIALS – (TREES)

A. Wood Stakes: Straight, sound, rough sawn lumber 2 in. x 2 in., if square, or 2-1/2 in. diameter, if round. Stakes shall be stained dark green.

B. Webbed Strapping for Stakes: Flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength. Color to be Green. Product to be ArborTie manufactured by Deep Root Partners, L.P. or approved equal. Secure to stake with 1" galvanized roofing nail.

C. Submit manufacturer's product data for approval.

2.7 EDGING

A. Refer to Section 05 59 01, METAL EDGING.

PART 3 — EXECUTION

3.1 EXAMINATION OF SUBGRADE

A. Examine subgrade and rough grading before planting. Alert Landscape Architect to unacceptable rough grading or subgrade.

3.2 DRAINAGE OF SOILS

A. Test drainage of five plant beds and pits chosen by the Landscape Architect shall be done by filling with water twice in succession. The time at which water is put into the pit or bed for a second filling shall be noted. Landscape Architect shall then be notified of the time it takes for pit or bed to drain completely. Planting operations shall not proceed until Landscape Architect has reviewed test drainage results.

B. Notify the Landscape Architect in writing of all soil or drainage conditions that he considers detrimental to growth of plant material. Submit proposal and cost estimate for correction of the conditions for Landscape Architect's approval before starting work.

3.3 LAYOUT OF PLANTING AREAS

A. Individual trees shall be located in the field as indicated on the Drawings for Landscape Architect's approval prior to planting. Contractor shall provide one foreman, one loader with operator and two laborers to work in the field to determine the final location and orientation of each tree prior to planting. It is anticipated that this process may take several days to complete. Contractor shall plan to have this layout crew available to work Landscape Architect at a slow and deliberate pace in order to achieve the desired results.

B. Individual shrub locations and outlines of shrub and ground cover areas to be planted shall be staked by the Contractor in ample time to allow inspection by the Landscape Architect.

C. Individual vines and groundcovers to be planted shall be laid out in plant beds by the Contractor in ample time to allow inspection by the Landscape Architect.

D. Digging shall not begin until locations are approved by the Landscape Architect.

E. Location of trees shall be staked using color coded stakes. A different stake color shall be used for each tree species.

3.4 PLANT PIT EXCAVATION

A. Planting pits for trees and shrubs shall be excavated to the angle, depth and dimension indicated on the Drawings. Do NOT overdig the planting pits.

B. Excavation shall not begin until locations are approved by the Landscape Architect.

3.5 PREPARATION OF SUBGRADE

A. Refer to Section 32 91 00, PLANTING SOIL.

3.6 SPREADING OF PLANTING SOIL

A. Planting soil shall be spread and placed to required depths. Refer to Section 32 91 00, PLANTING SOIL.

B. Surfaces shall be graded and smoothed, eliminating all sharp breaks by rounding, scraping off bumps and ridges, and filling in holes and cuts.

3.7 PLANTING

A. Conduct installation so as to protect new and existing landscaping, site electric, drainage systems, paving, structures, walls, footings and foundations, waterproofing, and other work and utilities, from damage. Report damage to work of other trade(s) to Client, Owner's Representative, or Landscape Architect immediately. Make or arrange repairs to satisfaction of Client, Owner's Representative, or Landscape Architect.

B. Containerized plants shall be removed from container taking care not to damage roots. For trees and shrubs, the side of the root ball shall be scarified to prevent root-bound condition. Any wire baskets shall be completely cut away from sides of root ball and removed from pit. Bottom of baskets may remain.

C. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality in Part 2: Products.
   1. The Contractor shall undertake at the time of planting, all modifications to the root system required by the Owner's Representative or Client to meet these quality standards.

   2. The amount of excess soil above buttress roots to be removed should be determined in advance by the Landscape Architect. The planting hole should then be dug to a depth that will result in the root ball aligning with finished grade.

D. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.

E. Plants shall be turned to the desired orientation when required by the Client, Owner's Representative or Landscape Architect.

F. Planting shall be positioned in center of planting pit, set plumb, and rigidly braced in position until all planting soil has been tamped solidly around the ball.

G. Brace root ball of trees by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment.

H. Set plants shall have same relationship to finished grade as in the nursery. Root collars/flares shall be exposed as noted in the Drawings.

I. Planting soil/growth media shall be placed as specified in Section 32 91 00 PLANTING SOILS. Soil shall be worked carefully into voids and pockets, compacting lightly between lifts.
   1. When pit is two-thirds full, plants shall be watered thoroughly, and water left to soak in before proceeding. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.

   2. At this time, ropes or strings on top of ball shall be cut and shall be pulled back. Burlap or cloth wrapping shall be left intact around ball except that portions of wrap that are exposed at top of ball shall be turned under and buried. Non-biodegradable ball wrapping and support wire shall be totally removed from ball and planting pit.

   3. Remove nursery plant identification tags.

J. Backfilling and tamping shall then be finished and a saucer formed around plant pits as indicated on the Drawings.

K. Saucer shall be filled with water and water left to soak in. Saucer shall then be filled with water again.

L. Avoid walking and using heavy equipment in all planted areas.

3.8 PERENNIALS, GRASSES AND GROUND COVERS

A. Water all plants in original containers prior to layout.

B. Set out and space plants as indicated on the Drawings and Schedule.

C. Dig a planting hole equal to the depth of the root ball.
   1. Recommended planting tools for Landscape Plugs: earth augur or power drill with 3” augur attachment, hand trowel, weeding knife, trenching spade or pick axe

D. Place plant evenly in planting hole and work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 STAKING AND GUYING

A. All evergreen and deciduous trees 4” caliper or larger to be staked and guyed. Consult Owner’s Representative and/or Client to confirm the need for stakes for each tree after planting. If confirmed, each tree shall be staked or guyed immediately following planting.

B. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer’s recommendations and the Drawings for installation.
   1. Plants shall stand plumb after staking or guying.
   2. Stakes shall be driven to sufficient depth to hold the tree rigid.
   3. Set vertical stakes and space to avoid penetrating root balls or root masses.
   4. Allow enough slack to avoid rigid restraint of tree.

3.10 STEEL EDGING

A. Refer to Section 05 59 01 METAL EDGING.

3.11 MULCHING

A. Apply 2 inches of mulch, covering the entire planting bed area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper when abutting pavement.

B. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

3.12 PRUNING

A. Pruning shall be undertaken at the direction of the Landscape Architect. Each tree and shrub shall be pruned to preserve the natural character of the plant. Pruning shall be done after delivery of plants and after plants have been inspected and approved by the Landscape Architect. Pruning procedures shall be reviewed with Landscape Architect before proceeding.

3.13 MAINTENANCE OF PLANTING

A. Maintenance shall begin immediately after each plant is planted and shall continue through guarantee period until Final Acceptance.

B. Maintenance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings free of insects and disease, and in a healthy growing condition.

C. Planting areas shall be kept free of weeds, grass, and other undesired vegetative growth.

3.14 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the requirements of Division 01, GENERAL REQUIREMENTS for removal and disposal of construction debris and waste.

END OF SECTION